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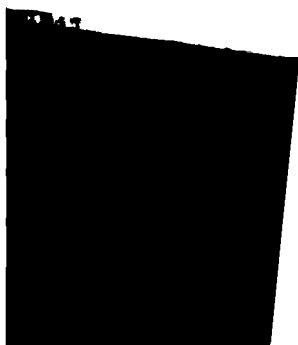
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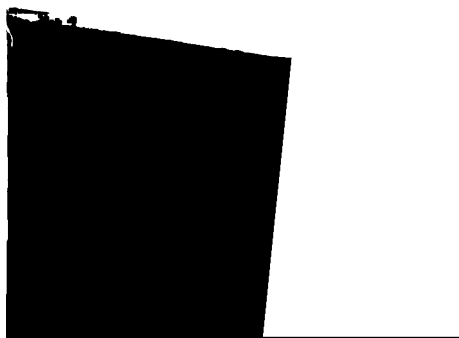
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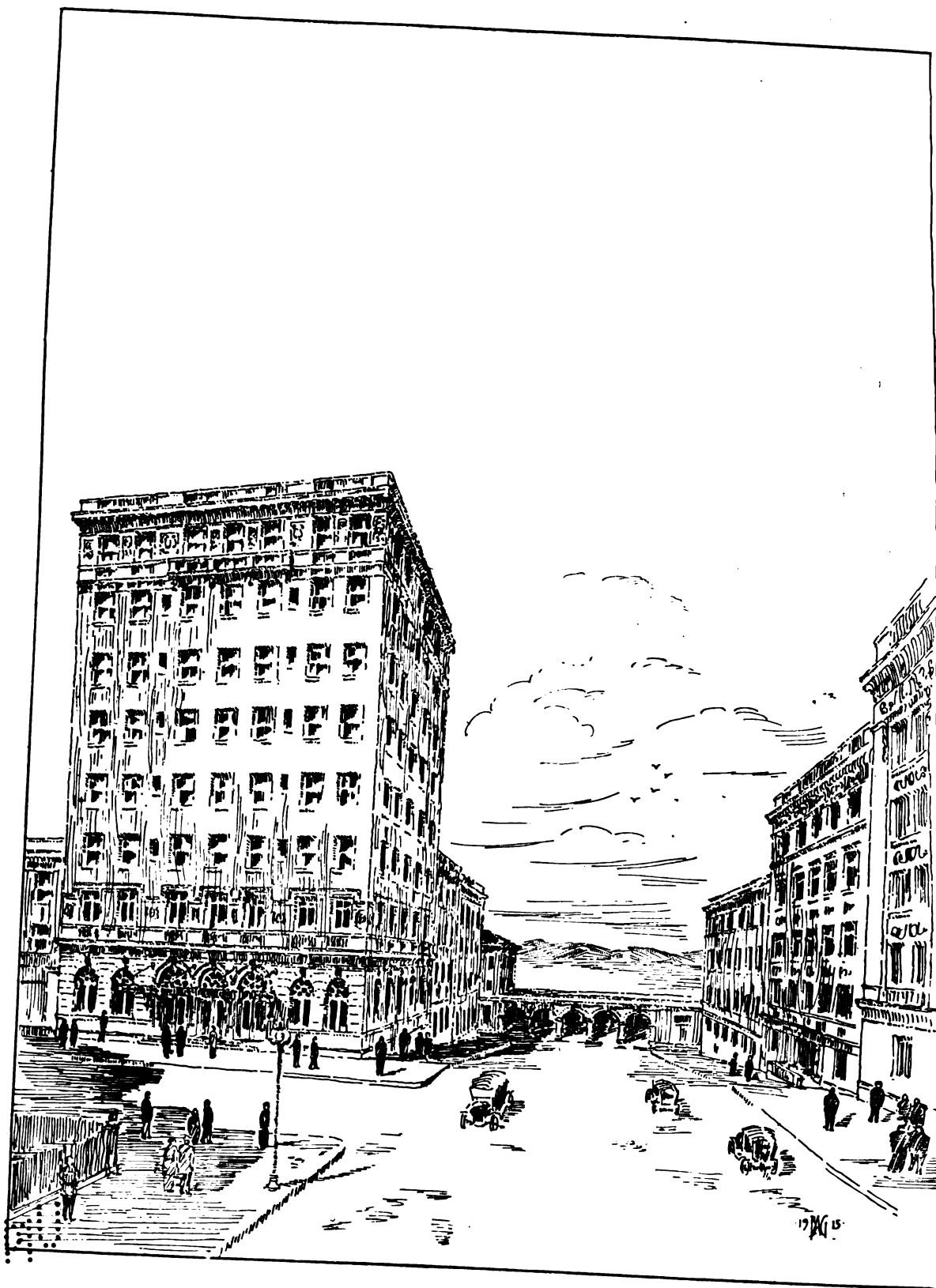


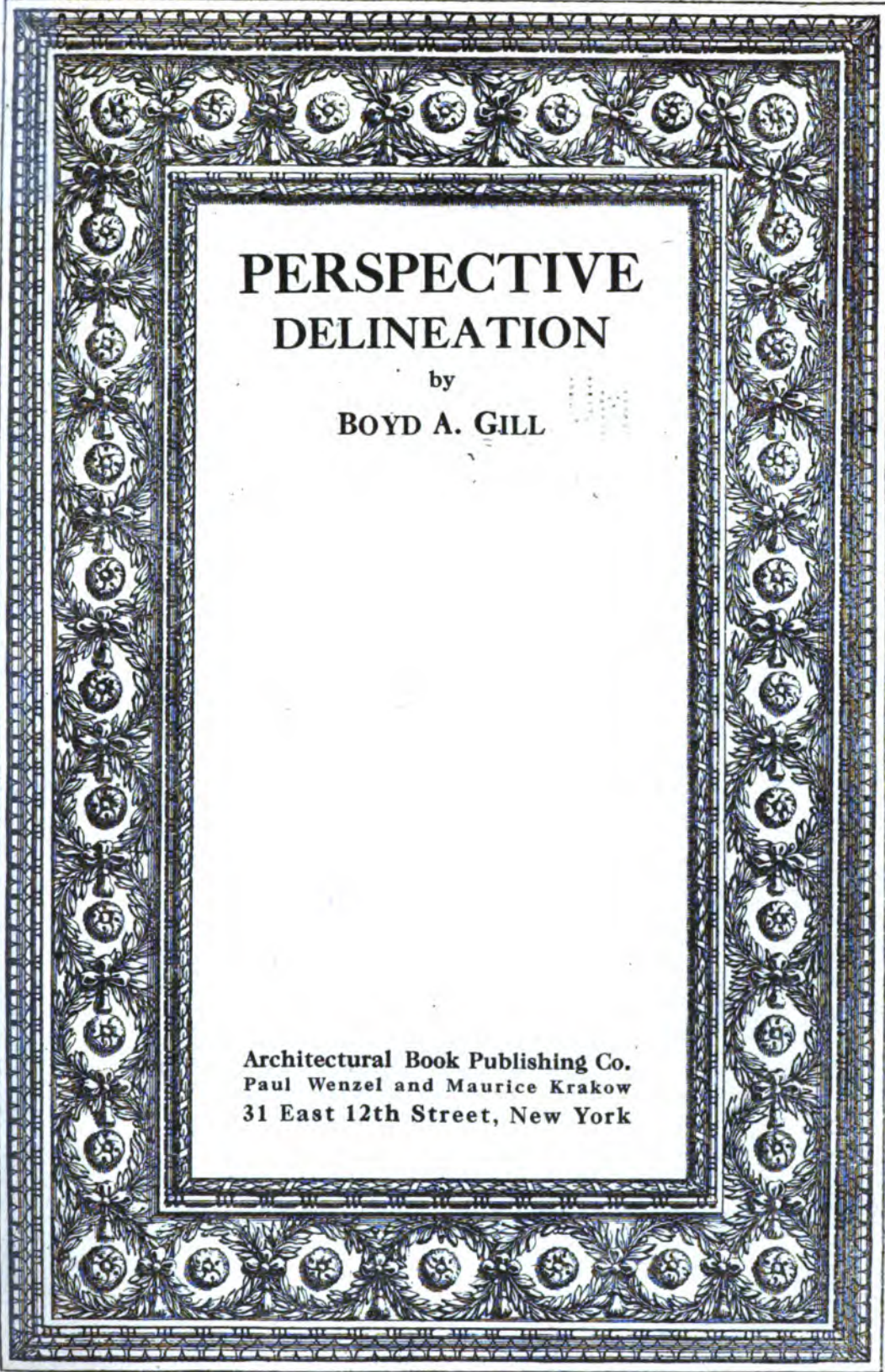






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PERSPECTIVE DELINEATION

by
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PAUL WENZEL AND MAURICE KRAKOW

Preface

TO offer an apology to my readers for producing another work on this subject would appear as an afterthought, with an open affection for a subject that has been very adequately discussed by numerous other authors. However, we all maintain a right to choose our books and methods that are best adapted to our individual purposes and should there not be sufficient material on the subject to meet our requirements, we could not gratify our desires.

Each author before starting the preliminary work on the subject which he desires to discuss, should first consider if the information to be conveyed will be of scientific value, if it is collective and has been derived from the advanced application of its theoretical principles, that have culminated from years of experience in the application of the principles of perspective, and will assist in the advancement of the art of perspective drawing to reach its highest attainments.

A treatise on the subject of perspective to be of practical value, should not be treated solely from the technical standpoint, nor should it be too brief and obscured by technicalities that are scarcely intelligible; so that it can be only used by the technical student, but in a measure it should be so treated that it can also be used by the general reader and used as a text book by the technical student. The method of delineation should be simple, yet comprehensive, with the exactness of mathematical calculations, with the least complications and elementary theories that have no purpose other than in the theoretical analysis of its primary principles. It should contain numerous examples of problems showing the method of procedure, to aid in arriving at a solution for similar problems, also examples of unusual conditions that have occurred in the practice of the delineator, or those that would come under the head of extreme conditions in perspective.

I can assure the reader that I have nothing to offer that in a sense could be considered as new or a novel method of perspective delineation, that I have not otherwise found in my researches, as every method has been presented in some form or other to the technical student by other authors, and it should not be supposed that there will not be discoveries made of methods and principles as portrayed in books by little known and forgotten pioneers, which should be considered as the height of attainment in perspective delineation for that period. But if the reader will accompany me he will discover some things that are rather novel, and perhaps new to him, inasmuch as he will obtain some points of view from the more familiar ground as they will present an unaccompanied aspect.

In this work I have endeavored to present to my contemporaries a method of drawing perspectives by the perspective in plan method and the only endorsement that I ask is that they will try it when an opportunity occurs.

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Introduction

THE true origin of perspective drawing will always remain veiled in obscurity, all records of the researches made by the Greek Authors in their attempt to solve the elementary principles of perspective, as used in their theatrical decorations and as referred to in the writings of Vitruvius are extant. There was little known about the art of perspective drawing before the beginning of the sixteenth century, though the works by the earlier authors of that period we know by tradition only. The first work of any prominence in the English language is that of Dr. Brook Taylor, *Linear Perspective* (1715), in which perspective is reduced to mathematical principles.

The aim of each author in writing on a technical subject is to present it from a different point of view, as he wishes to incorporate a new set of principles that he has formulated in his practice, or as a tutor; not new in a sense but the perfecting of a system or a set of principles that have been in practice, therefore this work should have no difficulty in finding its place among the numerous works by other authors that have labored in these regions and have given to us that which can not be obliterated with time.

The principles of Descriptive Geometry founded by Monge in the seventeenth century, enabled his contemporaries—the authors of treatises on the subject of perspective—to obtain solutions for the difficult problems that they had long striven to solve. It might be said without recourse that the principles of Descriptive Geometry form the basis of elementary perspective, as we are told by our tutors; for they declare that it is supreme discipline for the mental faculties, as it enables them to cover sheets of paper with abstruse and intricate demonstrations pertaining to objects in space as projected on two planes at right angles to each other; however, I fail to find much affinity between the two; as only in parallel perspective the delineator is working with two planes at right angles to each other, the earth's plane and the picture plane, the object rests on the earth's plane and the picture plane is parallel to one of its faces. In angular perspective, the picture plane forms acute angles with two faces of the object and it is perpendicular to the earth's plane; by a perspective drawing we cannot ascertain the exact size of the object from the perspective, as they do of a body in space by descriptive geometry.

In the average treatise on perspective, the elementary principles of perspective are elaborately treated, consisting of numerous problems to be worked out by the student, if he is not his own tutor; but the aims of the average student do not follow this trend, as problems of this character are very difficult to grasp, and it is difficult to ascertain their connection with perspective; the expectation of reaching the desired goal seems to vanish the horizon, therefore he will quickly seek other sources of informa-

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tion. The sole aim is to produce a drawing that is a close imitation of the edifice in perspective, as the image is conveyed to the mind, without having a knowledge of its fundamental principles. This can be likened to all students and should not be denied them, even though the results obtained are very mediocre. It may be the best—but it is none too good, as it certainly will be belittled later by other works of real art, when they have satisfied themselves that they can draw a perspective; then afterwards learn something of its fundamental principles. For this reason it was thought best to eliminate a considerable part of the work in elementary perspective and by defining the technical terms used in perspective delineation—The Ground Line, Horizon, Vanishing Points, Picture Plane, Station Point and the different methods of perspective drawing, giving the reason for their uses and the various methods of projection, so as to arrive quickly at the real work in perspective delineation, of problems in advanced perspective.

Perspective delineation is a mere matter of projection from a point in a designated plane to a point in another plane, which may be located back of it, in front, above or below the plane mentioned, and from this position a portion of the perspective will be delineated. The various plates composing this volume have been drawn with this point of view in mind, and as a new principle is to be arrived at, it has been fully demonstrated by the methods of projection, leaving nothing of indefinite nature that would delay the progress of the student.

Perspective

A MENTAL CONCEPT OF THE OBJECT IS FORMED
AS IT APPEARS TO THE EYE IN PERSPECTIVE.

PERSPECTIVE is the art of representing on a plane surface objects in their apparent form at various distances from the eye, not as we know them to be, but as they appear to the eye in perspective. In this respect it differs from a positive or a geometrical illustration and it may be called pictorial geometry, which forms the basis of scenic design, because it governs the relation of objects by perspective principals.

The impressions conveyed to the mind through the sense of sight of our surroundings, is as it would be presented by a perspective drawing and not as it would be shown by a geometrical drawing. The optical convergence of all parallel horizontal lines may not have made an impression on the mind of the casual observer, as they have not made a comprehensive study of the art of perspective drawing, or compared a geometrical drawing with a perspective drawing, in which the difference will be readily noticed, whereas the geometrical drawing is likely to be little understood, but the perspective needs no explanation. It is a representation of that which surrounds us, as the eye readily recognizes the picture as that particular view had made a lasting impression on their memory. If we step forward or backward or turn about, our surroundings will be seen from a different point of view, but their perspective lineaments have not changed. All the horizontal lines entering into the composition of the objects that surround us, seem to converge to a point of infinity on the horizon. The apparent reason for this optical convergence cannot be satisfactorily explained or demonstrated, so we will have to allow it to pass without further discussion, as it is always present like the elements and the recurrence of the seasons, to this optical phenomenon we apply the term perspective. If the artist in delineating the objects that enter into the composition of his pictures ignored the convergence of the horizontal lineaments that are parallel to the horizon, then he would be drawing the objects the size he knew them to be and not as they appear to the eye in perspective.

Perspective can be divided into numerous sub-divisions, but all of them would come under one general heading, lineal or angular perspective. The only difference between them being the angle of view formed by the object with its relation to the picture plane. In angular perspective the vertical faces of the object are set to form acute angles with the picture plane, the width of these faces will vary according to the angle of view. For instance a cube with two equal faces when drawn in perspective at an angle of ten degrees, one face will be much narrower than the other, as shown on *Plate No. 29*, but when drawn in perspective at an angle of forty-five degrees both faces will be equal; therefore it will be readily seen

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how an object with two equal faces, when viewed at various angles of view, will appear in perspective.

The picture plane in parallel perspective is assumed to be parallel with one of the faces of the object, in delineating the object one vanishing point is placed at infinity on the horizon, the perspective is then drawn with one system of horizontal lines converging to this vanishing point and the other system of horizontal lines intersecting at right angles with the vertical. It is maintained by most authors that parallel perspective should be used for perspectives of interiors and street scenes, but as this method is so limited in its uses it should not be recommended for large perspective drawings.

When delineating a street scene in perspective the necessity of two vanishing points for the convergence of the parallel lines will be appreciated more so than by this description, as the view down the street all the parallel lines in that direction seem to converge to a vanishing point, the parallel lines running in the opposite direction also converge to a vanishing point on the horizon, if we are to draw it as we see it, or as it will appear in a photograph. See *Plates Nos. 8 and 9*. If the street scene is drawn in angular perspective, using two vanishing points, the objects would be viewed at an angle of ten degrees, which would give approximately the same view as that drawn by parallel perspective. By drawing the street scene in angular perspective all the difficulties encountered in parallel perspective will be overcome, also the appearance of the objects will be more agreeable to the eye. For illustrations of parallel and angular perspective see *Plates Nos. 1, 2, 3, 5, 6, 7, 8, 9*.

The picture plane in oblique perspective forms oblique angles with the faces of the object that are to be drawn in perspective. An object that leans toward or in the opposite direction from the picture plane will be drawn in oblique perspective. A church spire with inclined surfaces, a box floating in the water loaded on one side, or any leaning object, or one with its vertical faces out of plumb, these inclined faces would form oblique angles with the picture plane. *Plates Nos. 10 and 11*.

Aerial perspective is the art of representing on a plane surface one of the myriad aspects of natural phenomenon, as it is non-scientific in character, therefore there are no valid rules for its practice, as experience should be the ruling guide of the artist in faithfully portraying the myriad aspects presented by nature.

There are numerous short cuts for obtaining solutions in perspective drawing without using measuring points, but finding the perspective length of lines by direct projection, by using the orthographic plan, or drawing a perspective by using the station point and direct projection. These methods are better adapted for the purpose of geometrical demonstrations and small perspectives rather than they are for perspectives of any pretence. The only advantages that can be claimed for these methods are

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that the working drawings can be used by direct projection in place of drawing a perspective in plan. They also have many disadvantages as it takes up much more working space, with the subsequent projection of all the points on the picture plane often leading to errors, as it is necessary to transfer these projected points to the perspective, allowing for a greater number of errors. The application of a few primary principles, rather than a variety of principles, are the essentials to be sought in mastering the art of perspective drawing.

Accuracy is one of the primary essentials in perspective drawing, as there is a possibility of small errors being greatly magnified in the course of delineation. When the final drawing is started discrepancies that were not corrected at the opportune time are likely to mar the appearance of the picture in its entirety. This statement should not be interpreted as meaning that all perspective drawings should be made with a hard pencil for the sake of accuracy, whereas each line drawn leaves a groove in the paper, or that strict principles should be adhered to regardless of the effect it may have on the picture; but in the preliminary part of the work, that of laying out the measuring points and the projecting of points in front of and back of the picture plane should be carefully executed. To guess at the location of a subordinate motive without locating it on the perspective plan, then projecting it to the perspective, is likely to become a habit after a time, which will often lead to a point in question, the reason for the faulty appearance of the motive will be laid to distortion in perspective. The term distortion, often used by perspective delineators to cover up a multitude of faults in their perspectives, is very often misinterpreted. If the perspective is correctly drawn there should be no distortion. To sum up what is known as distortion, it is rather a fault of the delineator and not one of the sins of perspective.

The Ground Line

THE term ground line used in perspective delineation is the starting point for measuring the vertical heights on the object above or below the surface of the earth. The ground line may be located above or below the horizon. Inasmuch as the topography of the earth's surface varies greatly in different localities, there will be no two conditions that are exactly alike; in some instances the ground line will be a horizontal plane, as in others it will be inclined toward the object, or possibly it may drop in both directions from the starting point.

When the height of the ground line has been located above or below the horizon, it does not change with the undulations of the topography, but the difference in the level of the grade should be measured above or below this established point, then the height of all objects will be obtained by perspective projection from scale measurements on the vertical line of heights. If the plot of ground on which the object stands has an irregular

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contour, the ground line will converge to a vanishing point, following the same direction as the grade line shown on the geometrical elevations; the vanishing point for this line will be located in the vertical plane of the vanishing point for that system of parallel horizontal lines that converge to a vanishing point on the horizon.

The vanishing point for all inclined grades can be found by measuring the height of the rise in the grade above the starting point, then projecting this point to an established vertical line on the object, draw a line from the starting point to intersect this point, continuing it to the vertical line passing through the aforementioned vanishing point, the intersection of these two lines establishes the vanishing point for all horizontal lines that are parallel to the grade line shown on the geometrical elevations. If the grade line slopes downward instead of rising from the starting point, the method of delineation will be the reverse of that described above, the depth of the drop in the grade should be measured below the starting point then projected to an established point on the object. *Plate No. 33.*

Before laying out the ground line for the perspective there are numerous items that should be taken into consideration, namely, the viewpoint of the average observer, or the level of their eyes above the grade, which is about four feet six inches to five feet; this is also the horizon. If the ground line is placed at a higher level than the aforementioned for a perspective of a tall building, it always gives it the appearance of a photograph taken with a wide angle lense, also it is likely that the roofs of the accessories will appear in the picture; though there is no valid reason to criticize this feature of the perspective delineation, however it is a mere supposition that the average person will ever view the edifice from that height; therefore delineators should consider the viewpoint of the average person when they are establishing the level of the ground line, by placing himself at the same level as the other creatures that move about on the surface of the earth.

The Horizon

THE horizon to the observer is where the earth and the sky apparently meet, it is a neutral line on level with the eye, which retains the same position even though the observer has ascended to lofty heights above the surface of the earth. Figuratively, there are two horizons, one for the observer on the surface of the earth and another for the observer at any height above it. The distance on the surface of the earth that the eye can see from either location is fixed by certain geometrical principles.

When the observer's view of the horizon is unobstructed by objects on the surface of the earth, it then appears to be a horizontal plane, inasmuch as the maximum curvature in comparison to its circumference is relatively small, therefore it is not necessary to consider this curvature when delineating perspectives, as the subsidence from a fixed point in-



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creases with the square root of the distance, on a comparatively level section of ground the surface of the earth will partially disappear at three miles and any moving object upon it would be lost sight of at a distance of four miles. The prevailing conditions of the atmosphere will at all times limit the distance the eye can see on the surface of the earth, also the topographic contours of the earth's surface.

The horizon of the observer that has ascended to lofty heights above the surface of the earth, in a balloon that is fixed to the earth or other mechanical devices that are propelled through the air, the horizon will always be on level with their eyes, the earth's surface then appears like a huge saucer or a shallow bowl, the rim of the bowl is the horizon and a point directly below the observer is the geometric center of the universe. The horizon on the ocean or other large bodies of water is known as the visible horizon, inasmuch as there are no permanent objects to obstruct the view, as the masts are the first part of the ship to appear on the horizon followed by the hull, also the masts are the last portion of the ship to disappear below the horizon, conveying the impression that it had sunk below the waves or went over the edge, as the curvature of the earth is not apparent to the eye, however all moving objects on bodies of water appear or disappear in the same manner.

In bird's-eye view perspectives the horizon will be the dividing line between the foreground and the background though the more distant objects may be delineated as enveloped in an atmospheric haze, it can hardly be said that they are in the background of the picture. The location of the horizon can be determined in the studio by holding a horizontal cord or pencil on level with the eye.

In pictures it will often be difficult to determine where the dividing line between the foreground and the background occurs, figuratively there is no dividing line, as the motives in the background are blended into those of the foreground, also the details in the motives are more defined as they approach the picture plane. The motives in the background that are partially obscured by the atmospheric haze, which lends to the picture its aerial perspective, are also back of those in the immediate foreground, therefore it is a matter for the artist to decide, as in a collection of landscape pictures, it is likely that there would be various types of foregrounds and backgrounds taken from points of view at different levels.

Vanishing Points

PARALLEL lines that have their origin at a given point and are parallel to the horizon, appear to diminish in width as they recede from the eye of the observer, seemingly they meet at a point farthest from the eye, or at a point of infinity on the horizon. These points for each system of parallel lines are called vanishing points which may be located

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at different levels according to their inclination to the horizontal and the vertical planes. The vanishing points for any system of parallel lines, also for any angle of view are inseparable from certain geometrical principles of delineation, in so far as the converging horizontal lines, though they are infinitely extended they cannot subtend an angle of view of more than thirty degrees with the plane of the horizon, nor an arc of a circle of more than one-hundred and eighty degrees, or a semi-circle of which the horizon will be the base.

The vanishing points for any system of parallel lines, may be found by allowing the eye to follow the direction of their convergence to a vanishing point, in whatever plane they may be located. When the vanishing point for that system of parallel lines has been found, a horizontal chord or pencil held on level with the eye will give the position of the horizon, it will then be a simple matter to ascertain in what plane they are located. A system of lines coinciding to the raking lines of eaves, gables and pediments when extended to infinity, the vanishing point will be found in the vertical plane of the vanishing point, for that system of horizontal lines that converge to a vanishing point on the horizon. The convergence of that system of parallel lines may not be perceptible as those in a horizontal plane, as motives of this character are used sparingly in architectural composition, however, in a series of gables or pediments the convergence of the receding lines in the composition of the motives will be very noticeable.

The vanishing points for a system of lines in a vertical plane when infinitely extended will be found in the apex of the object. Parallel lines coinciding to those of a church spire, smoke stacks and the entasis of columns, have a vanishing point in a vertical plane passing through the center of the base terminating at the apex.

It is not essential that vanishing points be obtained for each system of parallel line of the various motives in the composition as in many instances it will not be necessary; but the object that is nearest the observer, should be carefully delineated by finding the vanishing points for each system of parallel lines that enter into its composition. In photographs this convergence is very perceptible, as the distance from the eye increases the magnitude of the motives entering into the composition diminish in size, as their remoteness becomes manifest, inasmuch as the horizon may be obscured by an atmospheric haze that renders distances indefinite; when this haze becomes more dense all the details in the composition of the motives will be lost sight of, then they will be silhouetted with the sky as a background, their mass will be the only part of them that is visible, this diminution is due to the angle subtended by the point of view.

When drawing perspectives of tall buildings there will be reason to think that the system of vertical lines in the composition should con-

verge to a vanishing point in space, however, if there is any convergence to this system of vertical lines it is not perceptible. If the viewpoint selected for a tall building is such that the building can be seen in its entirety and a plumb-line is held up to coincide with its vertical wall surfaces at one corner with space as its background, it will be readily seen that there is no convergence to the vertical lines as compared to those in the horizontal plane. In no instance would this convergence be perceptible, unless the vertical wall surfaces were designed to have an entasis like that of a column. Where the vertical wall surfaces are battered or stepped back as they are on some Gothic Church Towers in a decorative manner, the vanishing point for the battered or stepped wall surface will be found in the apex of the motive coinciding with the center line that passes through the base. The convergence of the vertical lines can be readily noticed in photographs taken with kodak lense tilted at an oblique angle to the vertical plane without using a wide angle lense, though the wide angle lense will not totally obviate this distortion in the vertical lines of the object, as there is a tendency for that system of lines to converge to a vanishing point in space. Photographs that show an inclination to the vertical lines are distorted, this distortion can be imitated in perspective by using congruate vanishing points, which are in pairs, the whole group will then be called tri-congruate, as this method of perspective delineation is of no practical value it will not be further considered.

Parallel lines other than those parallel to the horizon have their convergence point in the place of their origin. A beam of light coming through an aperture in the clouds, which illuminates a portion of the earth's surface, is the same width at each end, although the boundary lines of the beam seem to converge to a vanishing point farthest from the eye.

There are numerous examples among buildings where there will be no convergence to certain systems of parallel lines in the composition of the motives, the ground plan of these buildings is either half of a regular or an irregular polygon. The perspective of a building with an irregular ground plan would show three of the geometrical elevations in place of two as in the ordinary perspective. Each system of parallel horizontal lines on the side elevations when drawn in perspective will have a convergence point on the horizon, the same systems of horizontal lines on the third elevation, or the elevation nearest the station point, will connect the terminating horizontal lines of the other two elevations without a convergence point. *Plates Nos. 21 and 22.*

The Picture Plane

THE term picture plane used in perspective delineation has a corresponding meaning to the term plane used in geometrical demonstrations, inasmuch as it is assumed to be an imaginary, transparent, vertical plane, arbitrarily placed between the observer and the object

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viewed; it can be defined as a surface real or imaginary, parallel to the horizon and perpendicular to the surface of the earth, a section of which will be a straight line.

Perspective is the representation of objects on the picture plane as they appear to the observer when viewed from a station point. The picture plane as an accessory to the art of perspective drawing serves numerous purposes, in so far as it establishes the location of the principal motives in the picture, with their relation to the subordinate, also those that are located in front of this plane as well as those that are back of it.

The picture plane of the artist serves a slightly different purpose than that used in perspective delineation, inasmuch as it is arbitrarily placed between the station point and the objects viewed, in this position there would be a foreshortening of the objects in both dimensions, in their height and their length. In most pictures the principal motive in the composition is a short distance back of the picture plane, when the landscape pictures by the artist are compared with the architectural perspectives by the delineator, they will always appear slightly different on account of the location of the picture plane. The picture plane for the delineation of architectural perspectives is set to form acute angles with two faces of the object or is parallel with one of its faces, in this position it will cut through the portions of the object that project beyond the vertical wall surfaces, also through the projecting wings and accessories. The picture plane in the camera or the ground glass, is back of the station point, then the reflected image is inverted. The picture plane is back of the object when the projected image is larger than the object, as it often does in the delineation of the accessories for an architectural perspective.

A window will serve the purpose of a picture plane when the observer is stationed in a room, viewing a group of objects or a landscape out of doors, the picture is then represented on the picture plane. When the observer approaches the window the angle of vision from which the objects are viewed will be increased and more of the surroundings will be included in the composition, by stepping back from the window the angle of vision is decreased, then the view of the objects is taken from a greater distance, in so far as the sides of the window cut off a portion of the surroundings, eventually one object will fill the entire space between the sides of the window.

The Station Point

THE pictures of all objects drawn in perspective are viewed from a station point, the station point may be located on the surface of the earth or it may be taken from any point above or below this level, each situation will give a different view of the objects. The selection of a station point is a matter that requires more than a casual consideration, as any change in the point of view will have a reaction on the

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picture in its entirety; if the picture to be delineated consists of one principal object with its accessories, it is essential that the observer should be far enough away from it so as to see its topmost members without throwing the head back, so that only a portion of the object can be seen at one time. If the object can not be seen in its entirety from this point of view, the observer should step further back as any change in the location of the station point will suffice for correcting the defects of the first selected station point.

The location of the station point establishes the position of all of the principal points for the delineation of perspectives, in so far as it fixes the position of the vanishing points, the measuring points for the perspective in plan and the depth of the ground line below the horizon for the perspective. The station point should not be located too close to the object as the perspective will then appear distorted, nor at too great a distance from it as there will then be a maximum convergence to the parallel horizontal lines, also at a great distance from the object many of the principal details will be obscured by the atmospheric surroundings. The height of the edifice that is to be delineated in perspective will in each instance establish the distance that the station point should be from the picture plane by geometrical principles, inasmuch as the location of the station point moves in a circumferential line from the center of the semi-circle, the degree of the angle from which the object is viewed will increase or be decreased accordingly.

The eye will see indistinctly all objects that come within the range of vision, inasmuch as only one point on the object can be seen distinctly at the time the attention is concentrated upon it, all the other points on that object will be indistinct in proportion to the distance that they are from this central point; when this distance is increased until a line connecting the two points subtends an angle of thirty degrees then the receding point becomes invisible, therefore an angle of thirty degrees may be considered as the limit for the plane of clear vision. A figure consisting of two semi-circles representing that which is seen from the station point, the central point being the plainest in its apparent detail. This figure is then evolved into a figure consisting of three semi-circles, the two smaller within the larger, then the points remote from the center of vision will be seen at an angle of one-hundred and eighty degrees on a horizontal plane, it is likely that some individuals are able to see at this angle vertically, though all the points on the object will be indistinct in proportion to their distance from the central point.

The distance the vanishing points are from the station point, will be as the distance the station point is from the picture plane, multiplied by the cotangent of the angle of view. The measuring points for any angle of view, is the same distance on the horizon from the vanishing point, as the station point is from the vanishing point.

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To locate M use V' as a center and V'S as a radius, inscribe an arc of a circle S M. To locate M' use V as a center and V S as a radius, inscribe an arc of a circle S M'. The vertical line S P C, from the station point to the picture plane, is the axis line or the line on which all the heights are to be laid off to scale measurements for the perspective. The position C on the picture plane is the point around which the whole group of objects are rotated. The various points at which this position can be located in perspective delineation is shown on the block perspectives. *Plates No. 33 to 40 inclusive.*

Parallel Perspective

THE purpose of illustrating a technical work on perspective, is to convey to the mind of the reader, by illustration and description, the method of delineation used in the preparation of the plates, so that it can be followed up through the various manipulations, from a perspective nucleus to a completed perspective. These plates have been referred to when discussing the various technical terms as used in perspective, and are so arranged that each problem is a stepping stone to the desired goal; starting with the elementary problems and continuing to problems of more complex nature, that will require greater initiative on the part of the delineator in their execution. It is not intended that these plates should be copied line for line, but are to be referred to when desiring to obtain a solution for similar problems in perspective.

The rudimentary conception of perspective delineation was a perspective drawn with one vanishing point and a measuring point on the horizon, in which the picture plane is assumed to be parallel with one of its faces, the parallel lines nearest the observer are drawn so that the vertical and horizontal lines intersect at right angles, the parallel lines on the opposite side converge to a vanishing point on the horizon. This method of perspective drawing, though the simplest, should not be used for drawing perspectives of any pretense, as the defects are so apparent, that the perspective would appear as though it was distorted. It is better adapted to drawing small perspectives and geometrical demonstrations, such as entrance motives, cornices and other details, when it is desired to study them in perspective.

We shall now consider the position of the station point, or where the observer is located when viewing an object, that is to be drawn in parallel perspective, on *Plate No. 24*, there are three rectangles of the same dimensions, drawn from three angles of view, fifteen, thirty, and forty-five degrees to the picture plane, with a line drawn from the point of intersection with the picture plane, to a point, to intersect with the circumference of the semi-circle, which locates the station point of the observer starting with forty-five degrees, where the distance from the station point to the picture plane is the greatest, and continuing in a circumferential

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line to the station point, where the angle of view is fifteen degrees; the rectangle is set to form an acute angle on the left hand side of fifteen degrees, on the right hand side an acute angle of seventy-five degrees, to the picture plane, the observer is then very close to the object; as a semi-circle three feet in diameter, and a perspective drawn an eighth of an inch to a foot, for this angle of view, the station point would be thirty-six feet from the picture plane, or the corner of the object, if the observer approached the object so that the angle of view was one degree, he would then be standing as close to the object as would be consistent, unless he desired to ascend its perpendicular walls; therefore he could only see the part that was immediately in front of him. However, this need not be the situation, the angle of view of the object, can be ninety degrees and we shall still be able to draw it in perspective, we can move away from it, so that the viewpoint is parallel with one side of the object, and the picture plane is parallel with the front of it, the horizontal lines on one side will converge to the vanishing point on the horizon, on the front they will intersect with the vertical lines at right angles, then the perspective will be drawn in parallel perspective.

The station point, and the vanishing points will be equal distances from the center line of the semi-circle, as it is in a perspective drawn at an angle of forty-five degrees, or the center of the semi-circle is the vanishing point *V'*, and the vanishing point *V*, is the station point, so in order to see the object, the vanishing point will have to be moved along to a point on the picture plane, equal to about one-half, or one-third, of the distance from the center of the semi-circle, to the station point, the station point is moved an equal distance, to that of the vanishing points; but the position of the object remains where it was at the start, the measuring point, is the same distance from the vanishing point, as the station point, then the angle of view of the object is at ninety degrees.

Plate No. 1. All objects are drawn in perspective, as they would appear to the eye, projected on the picture plane from a station point. The upper figure shows how an object when projected on the picture plane, will appear in perspective, the picture plane is inserted between the object and the station point of the observer, and is parallel to one of its faces; in this instance there will be a foreshortening in the height as well as in the width of the object.

The lower figure is projected on two planes, viewed from different station points. The object can be viewed from any angle of view, and would be approximately the same in profile, the height of the object as projected would be elongated, or foreshortened, according to the distance the picture plane is from it, as the picture plane is set closer to the object, the projected image will be greater in height, as the picture plane is moved toward the station point of the observer, there will be a foreshortening in the apparent height of the projected image.

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Plate No. 2. The picture plane is inserted between the observer and the object, illustrates how the height of the objects in geometrical elevation, are foreshortened by perspective, as they recede from the eye, by the parallel lines piercing the picture plane; the upper illustration shows how they appear in perspective. The measuring point and the vanishing point should be located on the horizon with the ground line drawn about four and a half feet below the horizon, or the height of the observer's eye, the height of the lamp posts should be laid off on the line $a\ b$ and a line drawn from a to V' and one from b to V' ; this will give the height of the lamp posts in perspective, as they recede from the eye, they are spaced equal distances apart on the ground line, at the points c, d, e, f and g , a line drawn from c to M , at the point of intersection with $b\ V'$ will be the center of the first lamp post on the line $b\ V'$, a line from d to M at the point of intersection with $b\ V'$, will be the center of the second lamp post, the same operation should be repeated for the lamp posts located at the points e, f , and g , after these points on the line $b\ V'$ are located, draw perpendicular lines through them to the line $a\ V'$, which will be the center lines of the lamp posts, and show how they appear on the picture plane to the observer in perspective.

Plate No. 3. When arches and ellipses are to be drawn in perspective, they should be drawn from projected points on the orthographic plan, to points of intersection in perspective; for small arch openings, by dividing the semi-circle into quarter parts, the points of intersection of the vertical, horizontal and quarter axis, on the semi-circle are sufficient; but for larger arch openings, these should be subdivided for the sake of accuracy.

A semi-circle in perspective appears like an ellipse in a geometrical elevation, an ellipse in perspective like a semi-circle in a geometrical elevation. The arch openings on *Plate No. 3* for semi-circular arches, illustrates how these points are projected from the orthographic plan to the perspective; draw a semi-circle in plan and divide it into four equal parts, this gives the vertical, horizontal and quarter axis, project these points to the ground line by the measuring point, then vertically to the perspective. Draw a semi-circle with a radius of one-half of the diameter of the arch opening in the geometrical elevation, and project from the horizontal, vertical, and the quarter axis points to the perspective, by using the point V' , at the intersection of these axis points in perspective, draw the arch ring in perspective.

A series of arches in any plane, can be drawn in perspective by projecting in the manner above described, by laying out the width of the openings on the ground line, projecting to the ground line in perspective by the measuring point M ; from these points of intersection draw perpendicular lines to intersect with the lines projected horizontally from the axes points, to the vanishing points, then draw the arch rings in perspective.

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Plate No. 4. The picture plane is inserted between the station point of the observer and the geometrical elevation of the object, illustrating the method of projecting from designated points on the object, to the picture plane, giving the foreshortening in perspective. These points are projected to the station point of the observer by continuing them on a horizontal plane to a line at forty-five degrees, then projecting vertically to a line drawn at the same angle; starting from the ground line and projecting horizontally to a perpendicular line in the plane of the station point of the observer.

A line drawn from the station point of the observer to V' , on the horizon will give the ground line in perspective, the same points that were projected horizontally to the station point of the observer, are to be projected vertically from the object to the ground line. The measuring point M , should be located on the horizon. A line drawn from e to M at the point of intersection with $e V'$, at e gives the starting point for drawing the perspective, draw a vertical line from e to where it will intersect with the line drawn from d , in the plane of the station point to V' , this will be the height of the object in perspective, draw a line from k to M , at the point of intersection with $e V'$, draw a vertical line to intersect with $d V'$, this will be one side of the object in perspective.

Plate No. 5. The drawing of a perspective is analogous to drawing the geometrical elevations from the orthographic floor plans. The orthographic plan of the edifice, should be drawn as though it was laid out on the surface of the earth and a perspective drawn of it; this can be accomplished by drawing a horizontal line across the drawing paper, bisecting it for the center line; at each extremity of this line, place a vanishing point V and V' , bisect the distance from the center line to the point V' , and drop a perpendicular line to an indefinite point, with a set square of thirty and sixty degrees draw a line from V to intersect with this perpendicular line, this point of intersection we will call $S P$, and the intersection with the horizontal line or the picture plane, this point will be called C , draw a line from $S P$ to intersect with the vanishing point V' , the figure just completed is a large right angled triangle, and is divided by the line $C, S P$, forming two smaller right angled triangles within the larger one. Using $V S$ as a radius, draw an arc of a circle equal to $V M'$, with $V' S$ as a radius, draw an arc of a circle equal to $V' M$ — M and M' are the measuring points for the perspective in plan. Draw a line arbitrarily placed, parallel to the line on which the vanishing and measuring points are located, and equal in length to it, this is the line of measures or measuring line, lay off on this line, from the point of intersection with the line C to $S P$, on the left hand side, a distance equal to the dimension of one side of the object, that is to be drawn in perspective, as indicated by the letters $a b$ on the plate, on the right hand side of this line, lay off the distance equal to the other side of the object $b c$, draw a line from b to V' ,

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and one from b to V, this gives the two sides of the building in perspective plan without any definite length, draw a line from c to M, at the point of intersection f, on the line from b to V', draw a line to V, from a, draw a line to M', at the point of intersection d, on the line b V', draw a line to V' intersecting the line f V at e; the figure just completed is the perspective in plan of the building, as it would appear if it was laid out on the surface of the earth. The openings in the wall and the roof lines in the perspective in plan, are obtained by the same method of projection, by first laying them out on the measuring line, projecting them to the perspective in plan, then projecting these points from the perspective in plan perpendicularly to the perspective, and the heights from the geometrical elevation to intersect with those from the plan, by this method a perspective can be drawn, as it will appear on the picture plane from the station point.

Plate No. 6. When an interior is drawn in parallel perspective, the picture plane is assumed to be parallel with one end of the room, the station point will be a short distance back of this plane, where the picture plane is set perpendicular to the horizontal plane of the floor. The vanishing point is on level with the eye of the observer, and is usually in the center of the end of the room, that is parallel to the picture plane, although it can be set a little to one side if desired. The measuring point should be located on the horizon, equal to the distance the station point is from the vanishing point, either to the left or to the right of the point V'. The station point for drawing a parallel perspective of an interior, should not be taken at too great a distance from the picture plane, as the foreshortening in the side walls will be greatly increased and appear obliquely or edgewise, while a fuller view of the walls will be had, if the station point is nearer the picture plane, the position of the station point should be placed, by assuming a reasonable distance for the depth of the room.

Drawing a perspective in plan, for an interior, that is to be drawn in parallel perspective, enables the delineator to be more accurate in the projection of the points perpendicularly, to the perspective, the preliminary part of the work can be done on a separate sheet of paper, then pinned down over the paper on which the perspective is to be drawn. The line a d in the perspective is used as a ground line for the perspective in plan.

Lay off on the ground line a d, the openings in the side wall, these are to be projected to a line drawn from a to V, from the points g, h and i, draw lines to M; at the point of intersection with the line a V, gives the openings in the left hand side wall and the corner of the room, these points are to be projected perpendicularly to the perspective, from the points of intersection with the line a B in perspective plan, draw perpendicular lines for the height of the openings, as laid off on the line a b. If the openings are duplicated in the right hand wall, the points of intersection on the line a V, can be drawn horizontally across in the perspective in plan, to the

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line $d V$, it will then be a repetition of the method as described. However, should they not be duplicated in the right hand wall, then the openings in that wall should be laid off on the line $a d$, and projected to $d V$, then projected horizontally across in the perspective in plan, to the line $d V$, and projected perpendicularly to the perspective, or another measuring point, M' should be established on the right hand side of V , equal to the distance that M is to the left of V , and the openings laid off on the line $a d$, starting from the point d and drawn from these points to $d V$ in perspective plan, then projected perpendicularly to the perspective. The openings in the end wall of the room, are to be laid off on the ground line $a d$, and lines drawn from these points to V , to the point of intersection with the line from $e f$, then projected perpendicularly to $e f$ in the perspective, the height of these openings should be projected from the line $a b$ to V at the point of intersection with the line e and e they are to be drawn horizontally across the end wall.

Plate No. 7. An interior of a room drawn in parallel perspective and compared with a photograph taken from the same viewpoint, the photograph would show a slight convergence to the horizontal lines that enclose the end wall of the room, compare *Plates No. 6 and 7*. The apparent reason for this is that the lens in the Kodak conveys an image of the objects to the photographic plate in the same manner as the crystalline lens in the eye receives the rays of light reflected from objects. The lens in the Kodak is ground so that the rays of reflected light fall upon the photographic plate, in the same manner as they do upon the retina of the eye; although this slight convergence may not be apparent to the observer, yet it is present, and if we are to draw it in perspective as we see it, these lines would not be horizontal, as they converge to a vanishing point, according to the viewpoint of the observer, see *Plate No. 32*. Interiors are not satisfactorily drawn in parallel perspective, as the openings in the side wall pass beyond the plane of vision very quickly and appear distorted; a better view of the room is obtained by drawing it in angular perspective, showing only two sides of the room as illustrated on the plate referred to.

Plates Nos. 3 and 9. Street scenes can be drawn in parallel or angular perspective, at the delineators discretion; parallel perspective though more often used for perspectives of this character, will at some time bring up a question that can not be readily solved. To what vanishing point do the lines $a b$ converge, that run at right angles to those that converge to the vanishing point? For this question there is no answer in parallel perspective as they will have to be drawn horizontally, at right angles to the vertical lines that enter into the composition of the motives.

A solution for this problem is illustrated on *Plate No. 9*. The same scene is drawn in angular perspective, in which the horizontal lines converge to a vanishing point V' , and continue to rise as they pass beyond the plane of vanishing point V , from this point they pass beyond the plane

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of vision of the observer from the station point. This convergence will be apparent in photographs taken from the same station point, the horizontal lines continue to rise as they pass beyond the plane of the vanishing point, and will appear slightly distorted.

Oblique Perspective

OBJECTS drawn in oblique perspective will have a convergence point for the vertical and horizontal lines entering into the composition of the motive. This convergence point will be in the plane of the vanishing point. A cube drawn in oblique perspective will have three vanishing points two for the horizontal and one for the vertical lines forming the three faces of the cube. Objects with inclined sides such as cones and pyramids, the convergence point for their inclined sides will be in the apex, over the center of the base, with two vanishing points for the lines composing their bases, *Plate No. 10*. Boxes loaded on one side or where the load is at rest in one corner of the box and they are floating in water, there will be three vanishing points for their delineation in perspective. Two vanishing points for the parallel lines forming the top and bottom of the boxes and one for the vertical lines enclosing the ends of the boxes in oblique perspective. The inclined post will have three vanishing points, one for the boundary lines of the post, and one for the sign board, the third vanishing point for the reflection on the water, these vanishing points will be in the plane of the vanishing point on the horizon. *Plate No. 11*.

Plate No. 12. Parallel lines that are oblique to the picture plane, have their vanishing points in space, in the plane of the vanishing point on the horizon. Parallel lines composing hip roofs, valleys, gables, pediments and diagonals, when drawn in perspective, these lines vanish to points above and below the level of the eye. The height of the gable *c d*, is measured on the vertical line from *b* to *b'*, a line drawn from *b'* to *V'*, will intersect with the vertical line *c d*, in the center line of the rectangle, this will be the apex of the gable roof, a diagonal line drawn from *b* to *d*, and extended to the plane of the vanishing point *V'* above the horizon, will locate the vanishing point *V''*, which will be the vanishing point, for all parallel lines in the plane of the gables for the three edifices, on that side of the center line of the rectangle. A line drawn from *d* to intersect with the point *e* on the rectangle *a b e f*, and extended from *d* to the plane of the vanishing point *V'*, below the horizon will locate the vanishing point *V'''*, which will be the vanishing point for all parallel lines in the plane of the gables, on the other side of the center line of the rectangle. By this method of projection, the vanishing point for any system of lines, in any plane that is oblique to the picture plane can be obtained.

The three edifices of the same type can be drawn in perspective by any desired method, the station point method of the perspective in plan method, or by constructing a series of rectangles, in which their apparent

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width decreases according to their distance from the station point, after constructing the rectangle a b e and f, the height of the other two rectangles, will be as the height of the first, is reduced by the convergence of the parallel lines to the vanishing point V', after the first rectangle is constructed and the vanishing points set off on the horizon, any number of similar rectangles can be constructed as each successive repetition, will be reduced in magnitude as it recedes from the eye.

The Station Point Method of Perspective Delineation

FOLLOWING up the rudimentary methods of perspective delineation, through the various stages that the principles of perspective were developed, it was readily found that all perspectives could not be drawn with one vanishing point; or that a perspective from various points of view could not be drawn satisfactorily in parallel perspective, on account of the numerous limitations that surround this method. This method was evolved into a system, in which two vanishing points and an orthographic plan were used, using the station point as a measuring point for obtaining the foreshortening in perspective. When the orthographic plan is set in position, for the different angles of view on the picture plane, from its first position in parallel perspective the position of C is being moved in a horizontal line the orthographic plan forming acute angles with the picture plane; the station point also is moving in a circumferential line from the center of the semi-circle, following that of the orthographic plan, starting on the left hand side and finishing on the right hand side of the center line of the semi-circle. *Plate No. 24.* When the station point is moved in a radial line from the center line of the semi-circle, for any angle of view, and lines drawn parallel to the boundary lines of the orthographic plan, to a point where they will intersect with the picture plane, they locate the vanishing points for the perspective, which will then be drawn by the station point method. The station point method of perspective delineation, has always been used by delineators for drawing perspectives of any pretense; it can be said, that it combines all the elementary principles, that are used in the delineation of perspectives, into a composite form, to make a complete method of perspective drawing.

To start a perspective by the station point method, the orthographic plan should be placed at the head of the drawing board, set to form acute angles with the picture plane. We will consider that the edifice is rectangular in plan, and the angles formed with the picture plane is thirty degrees on the right hand side, and sixty degrees on the left hand side of the point of intersection; the preliminary part of the work is now complete, the next step will be to draw a line downward, the length of this line to scale will be one hundred and sixty-six feet from the picture

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plane. The vanishing points are located by drawing line parallel to the boundary lines, or sides of the orthographic plan, starting from the station point and continuing until they intersect with the picture plane, forming acute angles, respectively, of thirty and sixty degrees.

In this instance the right hand vanishing point will be out in space. This difficulty could be overcome by placing two drawing boards together, but space will not usually permit. The exact location of this vanishing point can be obtained by calculation and an arc of a circle drawn to this radius, but as a rule delineators are not mathematicians, and are likely to overlook this important part of their work, so vital to perspective, guessing at an arc of a circle, considering that it will answer the purpose; consequently the results will be badly distorted perspective or a perspective with a very slight convergence to the parallel lines on one side of the edifice and converge too rapidly on the other.

A method resorted to by delineators when using the station point method, and one or both vanishing points are out in space, is to divide the vertical line from the station point to the picture plane, into three or four equal parts, drawing small right-angled triangles within the large right-angled triangle; *Plate No. 14*, by this method the altitude will be reduced to one-quarter of its actual height, then its length can be conveniently scaled. In this problem it is one-quarter of one-hundred and sixty-six feet, or forty-one feet and six inches; draw a line from this point on the base, to an angle of sixty degrees, to where it will intersect with the altitude line, then scale the altitude of the small right-angled triangle. By calculation and the method above described, results are approximately the same. The altitude of the large right-angled triangle will be four times the altitude of the smaller one. We have now obtained the distance it will be to the vanishing point, that is out in space. Subtracting the distance it is from the vanishing point, to a point that will be on the drawing board, and the concave side of an arc of a circle, from the altitude of the large right-angled triangle, the result will be the radius of an arc of a circle. By cutting a curve out of a piece of cardboard or similar material to this radius, and securing it to the drawing board, it will serve the purpose of a convergence point, for all horizontal lines in that plane.

The method of using cardboard or wood curves for the delineation of perspective, when both vanishing points are out in space, for very large perspectives is illustrated on *Plate No. 15*. The various positions in which the tee-square is drawn, shows how the parallel lines on both sides of the object, can be drawn to a vanishing point that is out in space; by placing the cardboard curves back to back, attached to the left hand side of the drawing board.

The tee-square when using the cardboard curves, should have the upper edge of the tee-square blade, in the center of the tee-square head.

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If this pattern of tee-square is not to be had, the ordinary tee-square can be utilized for the purpose by driving two brads in the upper side of the tee-square head, at points that will bring the upper edge of the tee-square, in the center of the tee-square head.

The delineation of perspectives with the cardboard curves as described, have many disadvantages, that need not be described here, as all delineators are familiar with them, and should only be resorted to when another method can not be used. A set of curves should be cut for each perspective, or perhaps more, as the point of view first selected may not be desirable, if this should happen to be the situation, the first set of curves cut should not be used for the same perspective if the angle of view is changed and the perspective is to be drawn mathematically correct.

The foreshortening in perspective is obtained by placing the straight edge or tee-square, using the station point as a measuring point, and drawing parallel lines from the points on the orthographic plan, to the picture plane. Dots or dashes may be used at the delineators discretion, all openings in the wall and projections beyond the wall, should be indicated, along with the other subordinate objects, that will appear in the perspective. After this part of the preliminary work has been completed, the vanishing points can be brought down to a line, drawn across the paper representing the horizon, and drawing of the perspective started. *Plate No. 13.*

Delineators while performing the various manipulations with the tee-square, in the drawing of perspectives, have no doubt experienced that the tee-square head is often a disadvantage, when attempting to do rapid work, as all the converging horizontal lines are drawn with the tee-square, the vertical lines with a set square or triangle. In order to draw the converging horizontal lines on the right hand side, of the point C, the tee-square has to be turned over, or the blade will be the thickness of the tee-square head above the drawing board, in order to reach the vanishing point, on account of the shortness of the blade; a tee-square with a long blade has also its disadvantages.

These difficulties will be overcome by using a straight edge, or a tee-square with the head removed, movable pins or brads should be driven into the drawing board, at convenient points, as illustrated on *Plate No. 16*, which will facilitate matters to a great extent, and lessen the mental anxiety on the part of the delineator. Straight edges of different lengths will be found convenient for rapid work.

Continuing the usual practice in the delineation of perspectives, by the station point method, setting the orthographic plan in position, without considering what parts of it will project beyond the picture plane. The point of intersection of the orthographic plan, is usually one corner of the edifice, although this is a matter for the delineator to decide, as there will be no unusual conditions arise, if the point of intersection with

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the picture plane, was taken at some point on the projecting cornice, or the picture plane cut through the wall back of the corner if desired; however, there is no apparent reason for it, as there is a tendency toward making unnecessary work; for there will be in most instances, some part of the plan that will project beyond this plane, when it is set in position.

The foreshortening in perspective is obtained in the usual manner, by drawing parallel lines from the points on the plan to the picture plane, for those parts of the edifice that lie back of this plane. The picture plane in this instance, cuts through a portion of the projecting wing of the edifice, this will present a different condition than that which we have been accustomed to. Instead of following the usual method of projecting the points on the plan, to the picture plane, for the portion of the edifice that lies back of it, in this instance it will be the reverse of the method described; the points on the plan will be projected back to the picture plane, by using the station point as a measuring point. The point *a* is projected to *a'* on the picture plane, which gives the corner of this wing in perspective. This same method of procedure should be followed for all the other motives, in the portion that projects beyond this plane, by this method of projection all points in the portion of the edifice that project beyond the picture plane are obtained for the perspective. *Plate No. 17.*

The essential features of this method are correspondingly the same as used before, but the method of procedure is slightly different.

It is to enlarge upon the methods now in practice, and permit the delineator a wider range of operations with less limitations. Heretofore in order to start the preliminary work on a perspective, the orthographic plan was set in position at the head of the drawing board, some part of which was brought to a point of intersection with the picture plane, or set a short distance back of it, forming acute angles with this plane; the station point was then located and the position of the vanishing points obtained after obtaining the foreshortening in perspective in the usual manner the delineator was ready to start work on the perspective. The same method of procedure has been used in this problem with some modifications.

To start the preliminary work for a perspective by this method, it will be necessary to first assume the diameter of a semi-circle, this will be governed by the length of the drawing board, and the size of the perspective to be delineated; a semi-circle three feet in diameter for small perspectives and four feet in diameter for all average perspectives, a semi-circle five to seven feet in diameter is ample for all large perspectives. A line drawn across the paper representing the picture plane, should be bisected for the center line of the semi-circle, from this point the position of *C* can be established by calculation, or that part of the orthographic plan that will intersect with the picture plane. The position *C*, is the point about which the orthographic plane of all of the edifices, that are to

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be drawn in perspective is rotated, and is in a direct line with the station point, where the observer stands while viewing the objects. The delineator, in his endeavors to obtain a desirable view of the objects by changing the angle of vision is moving the position of the station point, in a circumferential line from the center of the semi-circle. By moving the station point about in this manner, the view of the entire group is changed and the distance between the center line of the semi-circle and the position of C, will be increased or decreased accordingly; but the position of the vanishing points remain as they were established by the assumed diameter of the semi-circle. The position C when the angle of view has been chosen should be checked by calculation, as it has a fixed relation to the diameter of the semi-circle. *Plates Nos. 13 and 24.* In the column of figures headed degree of angle on left, gives the angles of view from ten degrees to eighty degrees, the angle of view at which the orthographic plan is to be set, should be chosen; that which gives the most desirable point of view of the edifice, for this problem we will use an angle of thirty degrees, the next column of figures headed degree of angle on right is an angle of sixty degrees so the perspective will then be drawn to angles of thirty and sixty degrees. Assuming the drawing board to be four feet long and this dimension is to be used for all calculation, (for convenience of calculation fractions of a foot should be avoided.) In the next column of figures headed C, and for the same angle of view—multiplying this figure by the diameter of the semi-circle ($-.2500 \times 4$) and the result is -1.0000 equivalent to $1'-0"$, the sign before it is minus, so it will be laid off on the picture plane, on the left hand side of the center line of the semi-circle. This is one corner of the building, or the point at which the orthographic plan intersects with the picture plane. The orthographic plan can now be set in position, forming acute angles with the picture plane, of thirty and sixty degrees. In the column of figures headed S P, or station point, for the same angle of view—multiplying this figure by the diameter of the semi-circle and the equivalent of the scale used for the perspective to actual size ($.4323 \times 4 \times 96$) the result is 166.00 or $166'-0"$, this is the distance the station point is from the picture plane, and is to be laid off on a vertical line intersecting the picture plane at the point C. The results obtained by these calculations will be in feet and decimals of a foot, and are to be converted into feet and inches, from tables in text books giving these equivalents, they can be laid off on the picture plane with a scale or a ruler. By this method the position of C, or the point of intersection of the orthographic plan with the picture plane, and the distance to the station point on the circumference of the semi-circle have been found by a method of calculation, the right and the left hand vanishing points have been established by the diameter of the semi-circle. The plus and minus signs before the figures in the column headed C, indicate that these positions are to be laid off to the left, or to the right,

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of the center line of the semi-circle, minus is to the left and plus is to the right.

Degrees of angle on left	Degrees of angle on right	C.	S.P.
10	80	— .4688	.1719
15	75	— .4323	.2500
20	70	— .3802	.3229
25	65	— .3229	.3854
30	60	— .2500	.4323
35	55	— .1719	.4688
40	50	— .0885	.4896
45	45	+ .0000	.5000
50	40	+ .0885	.4896
55	35	+ .1719	.4688
60	30	+ .2500	.4323
65	25	+ .3229	.3854
70	20	+ .3802	.3229
75	15	+ .4323	.2500
80	10	+ .4688	.1719

Scale equivalents to actual size.

1/2" to one foot	=	1/24 actual size
3/8" " " "	=	1/32 " "
1/4" " " "	=	1/48 " "
3/16" " " "	=	1/64 " "
1/8" " " "	=	1/96 " "
3/32" " " "	=	1/128 " "
1/16" " " "	=	1/192 " "

After the preliminary part of the work has been completed, and the foreshortening in perspective obtained in the manner heretofore described, then the vanishing points should be brought down to a line drawn across the paper, representing the horizon and the work on the perspective started.

Delineators will readily see the great amount of work that has been eliminated by this method, as it establishes the position of the various points used in perspective delineation, by a method of calculation, that is very simple, and if it is desired to change the angle of view, it will be repetition of the method as described. The position of both vanishing points have been definitely located, if one of them is off the drawing board, it is a simple matter to locate a point that will be on the drawing board, that distance minus one-half the diameter of the semi-circle will be the radius of an arc of a circle, for the convergence of the parallel lines in that plane.

Perspective Plan by the Station Point Method

BY forming a mental concept of the orthographic plan of the edifice, as it would be laid out on the surface of the earth from which the building is to be erected, we have then a mental picture in mind of the perspective in the plan of that object as we proceed to erect mentally the enclosing walls and construct a roof on these walls it will complete our

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mental concept of the edifice in a perspective in plan. Throughout this mental operation, we have at all times viewed the object as it would be erected on an orthographic ground plan in perspective from a station point and maintained the same angle of view. Retaining this mental concept in the manner it was first conceived we shall now undertake to draw the perspective in plan, not on the surface of the earth, for we are not accustomed to drawing on substances of earthy consistency, and to actual size, but we shall draw it on paper, to a small scale from which we will draw a perspective.

The average delineator when using the station point method, has made no use of the perspective in plan, that can be drawn by this method, as shown in the illustration on *Plate No. 13*. If the perspective in plan method is adopted by the delineator, it would eliminate considerable unnecessary repetition, and enable the delineator to follow up each successive step as the work progressed, without referring again to the orthographic plans and the station point; these plans should show all the details that are to be drawn in perspective by perspective projection.

A perspective of a building, in which the design varied somewhat in the successive stories, a perspective plan should be drawn of each story, where there was any modification of the motives making up the composition. A perspective plan of the two sides of the building is all that need be drawn, in a six-story building, a plan of the first and second floors; the next three stories or perhaps more as the case may be, these would be alike in many details, only one plan need be drawn; a plan of the upper story, as there is likely to be some modification in the motives making up the composition, the plan of this story should show belt courses and other details, brackets, projections, brakes in the cornice and the planes of the various projections beyond the face of the wall, and the parapet walls; this should also show the small buildings on the roof, such as pent houses, skylights and smoke stacks, if they are to appear in the perspective. These plans should be complete, so the delineation of the perspective can be carried on without interruption.

The development of the perspective in plan, in connection with the station point method of drawing a perspective, is the only method in the mind of the author, in which inaccuracies and distortion, in architectural perspective can ultimately be avoided. The station point method of perspective delineation without developing a perspective in plan, involves considerable guess work on the part of the delineator; on account of the confusing array of points on the picture plane, as they are always a possible source of error; the delineation will be often criticized and the delineator will have to allow himself to be at fault, as we all do not see things the same way.

There are some examples of the perspective in plan, drawn by the station point method, although it seems not to be used extensively by

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delineators. A perspective in plan drawn by the station point method, and a perspective in plan drawn by the perspective in plan method, if the distance to the station point is the same for both, they should conform in all their respective dimensions.

Perspectives By the Perspective In Plan Method

STARTING with the elementary principles of perspective delineation, and illustrating briefly the various stages of development, through which these principles have passed, before they were combined into one composite method of delineating perspectives by the Station Point Method; considering that we have not as yet reached the climax, in the development of these principles, and that there will be discoveries made, at some future time that have not as yet been conceived.

The Perspective in Plan Method, is a further development or the evolution of the Station Point Method, as it continues to develop the elementary principles of perspective, that were combined into one method, for the delineation of Perspectives by the Station Point Method. Permit me to reiterate, that this statement is arbitrarily made with this supposition in mind—that, when perspectives are drawn by the Station Point Method a perspective in plan is drawn in connection with it, to enable the delineator to be more accurate in his operations.

Therefore, if we should draw a semi-circle one foot in diameter, and draw a perpendicular line through the center of the semi-circle, we have then located a point, from which all the required points for the delineation of perspectives by this method are obtained. The first point to be located is the point C, or the point of intersection of the orthographic plan with the picture plane, to locate this point we shall have to choose an angle of view; for this problem we will use an angle of thirty degrees on the left hand side, and sixty degrees on the right hand side, of the center line of the semi-circle. Take a thirty and sixty degree set square, lay it on the drawing, so that the longer side is parallel with the picture plane, and the apex coincides with the point of intersection of the picture plane with the semi-circle on the right hand side, the other point of intersection with the semi-circle, will locate the station point. A perpendicular line drawn from this point to the picture plane will locate the point C, on this plane, also draw a line parallel to the hypotenuse, or the longest side of the set square, to intersect with the semi-circle and the picture plane; reversing the set square, so that its long side is parallel to the perpendicular line, from the station point to the position of C on the picture plane, and the apex coincides with the station point, draw a line to intersect, with the intersection of the picture plane with the semi-circle. By this method we have obtained the position of the left and the right hand vanishing

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points V and V', the position of C on the picture plane, the point S, or station point on the circumference of the semi-circle; the points obtained in this manner should be lettered as indicated on *Plate No. 18*. To locate the measuring points for obtaining the foreshortening in the perspective in plan, use V' as a center and V'S as the radius, draw an arc of a circle to intersect with the picture plane, this will locate the point M. With V as a center and V S as a radius, draw an arc of a circle to intersect with the picture plane locating the point M', the second measuring point. The next measuring point to be located, will be for drawing all lines in the perspective in plan, that intersect the horizontal and vertical lines, at an angle of forty-five degrees. Take a forty-five degree set square, lay it on the drawing so that the hypotenuse, or its longest side, is parallel to the line drawn from S to V', the tip of one of its forty-five degree angles, coincides with the point S at the point of intersection with the semi-circle locating the measuring point X on the picture plane, as illustrated on *Plate 18*.

The perspective in plan method is a further development of the station point method, by using the measuring points to obtain the foreshortening in perspective, in place of the station point as used in the station point method. The comparison between the two methods is obviously made, with this supposition in mind, that when the station point method is used by delineators, a perspective in plan is drawn, in which case there is one essential difference between the two methods; it is necessary in the perspective in plan method to have a line of measures arbitrarily placed between the picture plane and the station point, and is referred to as the measuring line, as in the station point method it is used as a secondary picture plane, when a perspective in plan is drawn in connection with this method of perspective drawing.

The average illustration of the perspective in plan method shows a diagram with the two vanishing points and the measuring points located, with a perspective in plan drawn to an angle of thirty and sixty degrees, on the left hand side of the center line of the semi-circle, or at forty-five degrees, limiting this method of perspective to these two angles of view. This leaves a wide margin of intangibility, and the delineator in desiring to use this method would have to draw a semi-circle the actual size, in order to locate the vanishing points, for drawing the perspective in plan. In this event it would be rather cumbersome method, as it would be necessary to inscribe a semi-circle three, four, or perhaps seven, feet in diameter, whenever a perspective is to be drawn, or draw a semi-circle of a smaller diameter and locate the measuring points, then transfer them by using the dividers to a semi-circle of larger diameter. A semi-circle seven feet in diameter may not seem large, but when working space is cramped it will be looked upon in a different manner. However, this method can be reduced to a semi-circle of unit dimension, so that the whole operation can



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be performed on the average sized drawing board, and the drawing of a large perspective becomes a simple matter.

Perspectives are usually drawn to the same scale as the working drawings, although it is often advantageous to draw a perspective to a larger scale than the working drawings are made, on account of the foreshortening in perspective. In this respect the perspective in plan method has the advantage over the station point method, as a perspective in plan is to be drawn, all the openings and projections are to be put into scale measurements, the use of a larger scale for the perspective in plan and the perspective will then be a matter of choice.

When the perspective in plan method is used, a block perspective of the edifice can be made without detail and the perspective view considered, it may be desirable to use a different angle of view, on the left or on the right hand side of the center line of the semi-circle, all that will be required is a mathematical calculation and the shifting of the measuring points from one position to the other, and redrawing the perspective in plan.

To start the preliminary work for a perspective by the perspective in plan method, we will first assume the diameter of a semi-circle, a semi-circle three feet in diameter for small perspectives and four feet in diameter for all average perspectives; a semi-circle five to seven feet in diameter is ample for all large perspectives. We will assume that we are about to draw a perspective of the average size; its plan is a rectangle one hundred feet on the front and sixty feet on the side; the height is one-quarter of its length, or twenty-five feet.

Assuming the diameter of the semi-circle to be four feet, and this dimension is to be used for all calculation (for convenience of calculation fractions of a foot should be avoided). In the column of figures headed "Degree of angle on left" are given the angles of view from ten degrees to eighty degrees. For this problem we will use an angle of thirty degrees, in the next column of figures headed "Degree of an angle on right," is an angle of sixty degrees, so the perspective will be drawn to angles of thirty and sixty degrees. In the next column of figures headed M, or the first measuring point and for the same angle of view, multiplying this figure by the diameter of the semi-circle ($-.3646 \times 4$) the result is -1.4584 , equivalent to $1'-5\frac{1}{2}"$, the sign before it is minus, so it will be laid off on the picture plane, on the left hand side of the center line of the semi-circle. The next column of figures headed C, for the same angle of view, multiplying this figure by the diameter of the semi-circle ($-.2500 \times 4$) the result is -1.0000 , equivalent to $1'-0"$, the sign before it is minus, so it will be laid off on the picture plane, on the left hand side of the center line of the semi-circle. In the next column of figures headed X, for the same angle of view, is the measuring point for all lines that are to be drawn in the perspective plan at an angle of forty-five degrees, such as mitre points, hip roofs and valleys; this is to be multiplied by the diameter of the semi-circle



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and laid off on the picture plane as indicated by the sign before it. In the next column of figures headed M', the second measuring point, this figure is to be multiplied by the diameter of the semi-circle ($+.0000 \times 4$). The result of this calculation would be four ciphers; this position will be on the picture plane, on the center line of the semi-circle. In the last column of figures, for the same angle of view, under the heading S P or the station point, gives the distance the station point will be from the picture plane, this figure is to be multiplied by the diameter of the semi-circle, and the equivalent of the scale used to actual size ($.4323 \times 4 \times 96$) the result is 166.00 or 166'—0". As the station point is not used for obtaining the foreshortening in perspective, in the perspective in plan method, this calculation need not be made, unless it is desired to know how far the station point is from the picture plane, and the object that is to be drawn in perspective. The results of these calculations are in feet and decimals of a foot, they are to be converted into feet and inches from tables in a text book, giving these equivalents, they can be laid off on the picture plane with a scale or a ruler. By this method the position of the measuring points, the point of intersection of the orthographic plan with the picture plane, or one corner of the building, and the mitre points or lines at an angle of forty-five degrees, have been found by a method of calculation; the left and the right hand vanishing points, were established by the diameter of the semi-circle, we are now ready to start work on the perspective in plan.

Degree of angle on left	Degree of angle on right	M	C	X	M'	SP
10	80	— .4844	— .4714	— .3516	— .3281	.1719
15	75	— .4661	— .4349	— .2917	— .2448	.2500
20	70	— .4401	— .3828	— .2344	— .1589	.3229
25	65	— .4063	— .3229	— .1823	— .0781	.3854
30	60	— .3646	— .2500	— .1328	+ .0000	.4323
35	55	— .3177	— .1693	— .0859	+ .0755	.4688
40	50	— .2656	— .0859	— .0417	+ .1432	.4896
45	45	— .2083	+ .0000	+ .0000	+ .2083	.5000
50	40	— .1432	+ .0859	+ .0417	+ .2656	.4896
55	35	— .0755	+ .1693	+ .0859	+ .3177	.4688
60	30	+ .0000	+ .2500	+ .1328	+ .3646	.4323
65	25	+ .0781	+ .3229	+ .1823	+ .4063	.3854
70	20	+ .1589	+ .3828	+ .2344	+ .4401	.3229
75	15	+ .2448	+ .4349	+ .2917	+ .4661	.2500
80	10	+ .3281	+ .4714	+ .3516	+ .4844	.1719

Scale equivalents to actual size:

1/2"	to one foot	=	1/24	actual size.
3/8"	" "	=	1/32	" "
1/4"	" "	=	1/48	" "
3/16"	" "	=	1/64	" "
1/8"	" "	=	1/96	" "
3/32"	" "	=	1/128	" "
1/16"	" "	=	1/192	" "

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To start the perspective in plan, draw a horizontal line arbitrarily across the drawing, below the line representing the picture plane, on which the positions are located; this will be the line of measures or measuring line, draw a vertical line to intersect with the position C, on the picture plane; this will be one corner of the building that is to be drawn in perspective, the length and breadth of the building are to be laid off on the measuring line, A B and C, *Plate No. 19*. Pins or short brads should now be driven into the drawing board at the right and the left hand vanishing points, V and V' and the position of the measuring points, M X and M'. The measuring points M and M' will only be used for obtaining the foreshortening in the perspective in plan, the measuring point X for lines at an angle of forty-five degrees, and where a shadow will be cast on a vertical wall surface, when the source of light is assumed to be at an angle of forty-five degrees; after the perspective in plan is completed, the measuring point positions can be removed. Draw a line from B to V and one from B to V', this gives the two sides of the building in perspective in plan, without any definite length. Lay off on the measuring line one hundred feet from B to C, draw a line from C to M, to intersect the line B V' at f, from f draw a line to V; this will be the front of the building in perspective plan. Lay off on the measuring line from A to B sixty feet, draw a line from A to M', at the point of intersection with the line BV at d, draw a line from d to V', intersecting the line fV at e. The figure just completed is the perspective in plan of the edifice, as it will be foreshortened by the angle of view from a station point. Bisect the line from A to B, draw a line from this point to M', to bisect the line Bd in the perspective in plan at g, from g draw a line to V', this line divides the perspective in plan into two equal parts, and forms the ridge of the hip roof, from B draw a line to X, to intersect the line gV' at h, and a line from X to e continued to intersect the line from g to V', from d draw a line to the point h and one from i to f, these lines from the hip roof in perspective in plan. The pins in the measuring points can now be removed, as the perspective in plan will not be carried further for this problem, tracing paper should now be pinned down over the perspective in plan and work on the perspective started. A line representing the horizon should be located, it is always on level with the eye of the observer, about four feet and six inches above the ground line, the ground line is where the vertical wall surfaces meet the surface of the earth. Draw a perpendicular line representing the corner of the building in perspective, at the intersection of this line with the horizon line, measure off four feet and six inches below this point, for the position of the ground line. The left and the right hand vanishing points, V and V', should now be brought down to the horizon line, in the same positions on the horizon line, as they were on the line of positions for the perspective in plan, that is the distance between them should be the diameter of the semi-circle.

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A line drawn from the corner of the building, at the ground line to V and one to V', gives the ground line in perspective.

The height of the building should now be measured above the ground line, on the corner of the building and a line drawn from this point to V and one to V', this gives the height of the building in perspective. From the perspective in plan, on the left hand side, also on the right hand side, giving the length of the building, as foreshortened by the perspective in plan, draw a vertical line at each end, completing the front and the side of the building; from the point g on the perspective in plan, draw a perpendicular to the perspective, measure the height of the hip roof on the corner of the building, draw a line from this point to V, intersecting this perpendicular line in the perspective, from this point draw a line to V', this is the ridge of the roof in perspective; project perpendicularly the point h and i to the perspective, that intersect the line g to V', draw lines to intersect with points, that will form the hip roof in perspective. The block perspective is now complete, the method of drawing the other motives in perspective, that compose the architectural design, will be a repetition of the method as described.

The delineation of the perspective in plan of edifices, in which the roof is broken up into gables, forming valleys at their point of intersection with the body of the roof, hip roofs and the roofs of projecting wings, forming angles at forty-five degrees with the horizontal, and projecting bay windows, the point of intersection should be located and drawn in the perspective in plan, by the measuring point X, continued until they intersect with a line that forms a part of the plan that they are to become a part of.

In the various illustrations the position of C has been marked, as it is the line on which the vertical heights are to be put into scale measurements, regardless of where this position is located; it is always moved on a horizontal line representing the picture plane, a group of objects can be located in front of this plane or in back of it. *Plates Nos. 33 to 40, inclusive.*

When necessary the right and the left hand vanishing points can be set in one-half inch from the edge of the drawing board. This difference in the diameter of the semi-circle need not be taken into consideration, as it will not affect the perspective in any manner.

Cities in which the streets do not run at right angles to each other, as in some instances for the sake of variety streets and avenues are introduced into the layout that run diagonally through the city or branch off from one of the main arteries at different angles. At the intersection of streets running at right angles, or at opposite angles to thoroughfares of this character, plots of ground of very irregular form are to be had, and are sometimes used for building sites. The common forms are a one-half of a regular polygon, triangular or a trapazeum; however, these plots of

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ground are usually left open and given some landscape treatment, and called a Plaza or Square in commemoration of some Patriot, or otherwise named. When plots of ground of this character are to be used for building sites and the edifice is to be drawn in perspective, it often presents a perplexing problem for the delineator. Four examples of this type of perspectives are illustrated on *Plates Nos. 21 and 22*. We have to first consider that the orthographic plan of the edifice can be enclosed by a rectangle, or a square, as it has been derived from this geometrical figure, with parts added to or cut away from it. After the angle of view has been chosen, then the perspective in plan can be drawn and the vanishing points for the oblique angles found. The length of the two sides of the edifice, as enclosed in a geometrical figure, of a rectangle or a square, should be laid off on the measuring line from A to B and B to C, also that portion of the edifice that is cut off by the intersection. The length of the sides in the orthographic plan are to be laid off on the measuring line and projected to the sides of the rectangle or square drawn in perspective in plan, by the measuring points, then to the vanishing points; from a to a' by M', and from f to f' by M, thereby locating the two points on the rectangle a' and f'; in this instance it is the front of the building, in which the diverging horizontal lines of the other two sides of the edifice in perspective, will be connected by the parallel horizontal lines of this elevation. Measure off the length of one side of the edifice on the measuring line a to b, by the measuring point M', locate b' on the rectangle, or the line drawn from B to V, draw a line from b' to V'. The distance from f to g is the length of the base of a right-angled triangle, or that portion of the edifice that is cut off of the rectangle or square in the orthographic plan of the edifice, this distance to be measured on the measuring line f to g and projected from these points to the rectangle by the measuring point M, locating g', from g' draw a line to intersect the line from b' to V', locating the point c, this gives the length of one side of the edifice in perspective in plan; a line drawn from d to d' by M' to intersect the line BV at d' and continued to the vanishing point V' will locate e, at the point of intersection with the line h'V. The distance from f to h is the length of the other side of the edifice measured on the measuring line, h is projected to BV' by M and then to V, intersecting the line drawn from d' to V' locating the point e, this gives the length of the two sides of the edifice in perspective in plan, a line drawn from a' to c and extended to the picture plane, also one drawn from f' to e and extended to the picture plane will locate the vanishing points V'' and V''' which are the vanishing points for the two sides of the edifice in perspective in plan; this completes the perspective in plan of the edifice. The vanishing points obtained in the manner described above are to be used for the delineation of the perspective in plan only, as V and V' are the vanishing points for the perspective.

The Principles of Perspective

THE theoretical analysis of the primary principles of perspective are of little value unless they are considered from a broader point of view, as the problems given in an academic course are of such minor nature and are so largely surrounded by theoretical limitations that it reduces the student's point of view to the narrowest margin. It leaves him drifting about in a sea of uncertainty, with little that is other than theoretical to rely upon when he attempts to apply what he has been taught to practical problems in perspective delineation, he is unable to produce credible results. Eventually he follows the same path that others have trod before him and enters that class of delineators who render perspectives by their own chosen methods, relying somewhat on good judgment, and what seems fairly correct perspective, or those who delineate perspectives without adhering to its established principles; as they are able to judge from the appearance of the finished work, what is fairly correct perspective. They maintain an uncertain attitude with regard to what they have produced. I guess that is about correct perspective.

The final definition for the theoretical analysis of the primary principles of perspective is to be found in trigonometrical demonstrations. That branch of mathematics that treats of the relation of the sides and angles of triangles with methods of deducing from certain given parts other parts required.

To illustrate how these trigonometrical principles are applied to theoretical perspective, we shall first consider the semi-circle which is divided into one hundred and eighty degrees or parts and each of these parts or points on its circumference to be a station point, from which an object is to be viewed. Considering that we will use fifteen of these divisions as station points, starting with ten degrees on the left hand side, and advancing to eighty degrees on the right hand side of the center line of the semi-circle, at each of these station points we would obtain a different view of the object, the viewpoint at eighty degrees will be the reverse of that at ten degrees, *Plate No. 24*. When the point of view is changed in this manner the distance the station point is from the picture plane increases up to the point of view at forty-five degrees and in turn diminishes as we approach the point of view at eighty degrees; as we move in a radial line from the center of the semi-circle, which in turn will react on our view of the object; as we approach the object we will see less of its height, on account of the angle subtended by the point of view.

The basic principles of this method are that all angles inscribed in a semi-circle are right angles, and that any right-angled triangle, which the dimension of one side is given, the length of the other two sides can be obtained by calculation, *Plates Nos. 18 and 23*. By assuming the distance the station point is from the picture plane to be one hundred and sixty-six

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feet, and the angle of view is thirty and sixty degrees, this dimension will be the base of a right-angled triangle, which we will call *a*, the length of *b* and *c* are to be obtained by calculation. The length of the line *b* will be measured from the point of intersection of the orthographic plan, with the picture plane, to the vanishing point *V'*, its length will be, as the length of *a* is multiplied by the cotangent of the angle of view ($b = a \times \cot. A$) or $166 \times 1.73205 = 288$; the length of the line *c* is to be measured from *S* or station point to *V'* then $c = \sqrt{a^2 + b^2}$ or $\sqrt{166^2 + 288^2} = 332.5$; this calculation is for a semi-circle four feet in diameter, and an angle of thirty and sixty degrees, the perspective is to be drawn to the scale of one-eighth of an inch to the foot. Therefore *M V'* is equal to *S V'* and *V S* is equal to *V M'* by this method, these positions are obtained by trigonometrical calculation, for the angles of view from ten degrees to eighty degrees, advancing by five degrees, and are given in tabulated form under the headings, degree of angle on left and degree of angle on right; for the degrees of angles or points of view, and the positions on the picture plane, *M C X* and *M'*, also the position of *S* or station point on the circumference of the semi-circle. The positions given in the tables on page 58 are for a semi-circle one foot in diameter, the results obtained by multiplying these figures, for an angle of view, by the diameter of the semi-circle, will be in feet and decimals of a foot, and are to be laid off on the drawing with a scale or ruler; the distance from the picture plane to the station point should be multiplied by the scale used to actual size and laid off on the drawing, according to the scale that is being used for the perspective. By this method of calculation, the theoretical principles of perspective are crystalized into concrete form, and are applicable to all forms of perspective delineation.

Heretofore we have considered perspectives that would be classed as small, medium sized and large perspectives, or those that could be drawn on a drawing board of average size, and pointed out briefly that it was unnecessary to go beyond the limits of a drawing board, to place the vanishing and measuring points, for perspectives in which their height did not greatly exceed their length. We shall now consider perspectives that will require drawing boards of greater dimensions, for drawing bird's-eye view perspectives, or a view taken from an aeroplane, in which the viewpoint is to be taken above the surface of the earth, so that a group of objects can be seen in their entirety, from an elevated point of view. Delineators are often called upon to draw perspectives that cover large areas of ground, such as the development of an estate for an institution, or for an owner of an estate, the campus of a university showing its extent and the proposed buildings to be erected in the future. Perspectives of this character are somewhat different from the average, as the delineator is not concentrating his attention on any one object, but on numerous objects, assembled in a composite group, mingled with planted

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areas and the undulating contours of the landscape, all the objects will appear slightly depressed, on account of the foreshortening in height, as well as in the other two dimensions. The delineator should exercise care in the execution and not attempt to draw objects in the picture that are directly below his point of view, or those that will not come within the confines of the focal angle. The assumed position of the picture plane should be located about the center of the group, so that the objects in the distant foreground that are a unit of the group will not be obliterated by the aerial perspective that performs a very important function in perspectives of this character.

To obtain a comprehensive idea of the group in its entirety, a preliminary drawing or a small scale study should be first made before the final drawing is started on a larger scale. This will enable the delineator to consider the group of the motives, the point of view and numerous other items that did not manifest themselves when first considered. This sketch need not be worked out in detail, or made into a finished drawing, as it is only for a preliminary study and a record for the delineator, to show that the work was started, should it be decided that the development was not to be carried out.

A conservative estimate of the prevailing conditions will guide the delineator in his preliminary undertakings, first considering the height of the eye above the surface of the earth, the distance he can see on the surface of the earth from an elevated position, and what will come within the confines of the focal angle. The height the observer is above the earth's plane should be given careful consideration, as the hazy appearance of objects, due to their aerial perspective, is a very important item and should be treated with some consideration as to its presence; it is quite essential that the horizon appears in the picture as it should not convey a false impression in the mind of the casual observer, to whom the picture is to make a just appeal. The distance the eye can see on the surface of the earth, from that height, will by calculation give the distance it will be between the vanishing points.

The Focal Angle

ASSUMING that the focal angle of persons with normal vision is thirty degrees to the plane of the horizon, that is, the rays of light reflected from objects are received by the eye at an angle of sixty degrees, measuring in a horizontal and vertical plane, thirty degrees above the horizon and thirty degrees below the horizon, and in a direct line toward the object, to the left and the right of the observer's point of view. *Plate No. 25.* Using the focal angle as a basis, all the points used for the delineation of the perspectives by the perspective in plan method can be obtained by calculation. Although it will only be necessary to resort to this method of calculation for very large perspectives, or perspectives of

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edifices in which their height greatly exceeds the other two dimensions, such as perspectives of multi-storied buildings and bird's-eye view perspectives.

To illustrate more clearly what is meant by this statement, though there are no fixed rules that can be abided by, leaving it to the better judgment of the delineator to decide on what will be the best solution for the problem in hand. The distance the observer is from the object and the angle from which the edifice is to be viewed has a relative bearing on a distant point to which all horizontal lines appear to converge; the position of this convergence point is to the station point of the observer as the square root of (a' plus b'). Therefore if a line were drawn from the station point of the observer to the object and its length ascertained, which we will call a , the distance the convergence point is from the point of intersection of this line with the object will be as a is multiplied by the cotangent of the angle of view. *Plate No. 23.* The application of these formulas for locating the vanishing points and measuring points to the problem at hand will give the diameter of a semi-circle, which will be the distance between the vanishing points V and V' , and other preparations can be made accordingly for starting work on the perspective.

When the height of the edifice above the horizon is over one hundred and eighty feet from a normal focal point of view on the earth's plane, the diameter of the semi-circle for a perspective of an edifice of this height will exceed seven feet, and the distance to the station point will be greater than three hundred feet. Considering that the scale used for the perspective is one-eighth of an inch to the foot, then it will be necessary to calculate the distance to the station point by the cotangent of the focal angle; if it is desired to view the edifice from a normal focal point, so as not to have it appear like a photograph taken with a wide angle lense, or the point of view taken at some height above the surface of the earth. *Plates Nos. 27 and 28.*

To illustrate this method of calculation for obtaining the distance it will be from the picture plane to the station point for a perspective of a multi-storied building, the observer is to see the edifice in its entirety from a normal focal point of view; that is, the full height of the edifice shall come within the confines of focal angle. *Plate No. 26.* The method for obtaining the distance to the station point of the observer from the picture plane is the same as that used for obtaining the distance it will be to the vanishing point, that is out in space, from the position C , or the point of intersection of the orthographic plan with the picture plane; in this instance it applies to the vertical height of the edifice, and is to be measured on a horizontal plane to the station point; after obtaining the distance to the station point, then this measurement can be used for obtaining the distance it will be to the vanishing points that are out in space by the same method. *Plate No. 26.*

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Assuming the height of the edifice to be five hundred and five feet above the ground line, and five feet from the ground line to the horizon, which is to be deducted from the height of the edifice for the purpose of calculating the distance to the station point.

The point of view of the edifice is to be thirty and sixty degrees, to obtain the distance it will be to the station point, will be as the height of the edifice above the horizon is multiplied by the cotangent of the angle of view ($b = a \cot. A$) or $500 \times 1.73205 = 866.25$, which is the distance in feet from the station point to the picture plane. To obtain the distance it will be from C on the picture plane to V', will be $866.25 \times 1.73205 = 1500$ feet, the distance from V to C on the picture plane for the left hand vanishing point, for an angle of sixty degrees will be $866.25 \times .57735 = 500$ feet nearly, this gives the distance it will be from the point of intersection of the orthographic plan with the picture plane, to the left and to the right hand vanishing points, and the station point in feet, they are to be laid off on the drawing with a scale, the positions of the measuring points can be obtained, either by calculation or by the method described. In this instance both of the vanishing points will be off the average drawing board and the perspective will have to be drawn the long way of the board. It then becomes necessary to use the cardboard curves as mentioned heretofore for drawing the perspective. For the figures used in making these calculations, by the cotangent of the angle of view, for obtaining the positions used in the delineation of the perspective in plan method, the reader is referred to F. E. Kidders, Architects and Builders Pocket Book.

Distortion in perspective delineation is often due to the fact that the station point is taken too near the edifice, as it is then viewed at too narrow an angle, to see the edifice in its entirety, the delineator is attempting to draw that which he cannot see from a normal point of vision, and the edifice may appear as though it spread out at the top. As the observer approaches the edifice, the upper stories will disappear from view. If the head is thrown back in order to see the upper portions, the lower portions of the edifice cannot be seen from this point of station, the focal angle would not be normal to the horizon. The station point should be taken at a sufficient distance from the edifice, so that the edifice can be seen in its entirety, when the focal angle is normal to the plane of the horizon.

Designing in Perspective

DESIGNING in perspective has not become universal among architects, as it is usually considered that perspective is a work of special character. Generally the Architect's geometrical drawings are submitted to the client for approval after the plans have been accepted and a perspective is demanded. An extra compensation is charged for this service as it is let out to delineators that specialize in this line of endeavor.

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In some instances, where designing in perspective is practiced in the offices of Architects, a perspective is submitted with the sketch plans. As this practice is so varied it is difficult to say to what extent designing in perspective is practiced by Architects.

Designing an edifice in perspective is in reality a simpler method of designing than designing the geometrical elevations separate; the necessity of rearranging the motives on one elevation to conform with those on the other elevations will be avoided. The designer is considering the arrangement of the motives on two elevations, and has a broader aspect of the whole situation, as it can be readily seen how the proposed edifice will enter into and become a part of the accessories.

Delineators who wish to dispense with matters of calculation and obtain the position of the measuring points without making a preliminary calculation for a sketch perspective; perchance they would have some reason to doubt the results obtained in this manner, on *Plate No. 31* are nine perspective scales, for angles of view from ten degrees to eighty degrees, giving the position of the vanishing points and the measuring points for a semi-circle one foot in diameter, according to the figures given in the tables under the heading M, C, X, M'. By using the dividers, to take off the distance from the center line of the semi-circle, to the left or to the right, of this point as it happens to be and multiplying this measurement by the number of times it is to be enlarged, according to the number of times the full length of the scale will divide the length of the line drawn between the established vanishing points. These scales should facilitate matters to a limited extent on work in perspective delineation. If greater accuracy is desired the measurements taken with the dividers can be applied to the scale below for actual measurement.

The orthographic plan of the average edifice, unless it is polygonal or triangular in form, is a rectangle, or a close approach to a square, as the length of one side is usually greater than that of the other; but the long side need not be the more important facade, in which case the edifice will have to be viewed from a different angle of view. On *Plate No. 32* are nine views of a cube, drawn at angles of view, from ten degrees on the left hand side, to eighty degrees on the right hand side, of the center line of the semi-circle; illustrating how an object with two equal faces, will appear in perspective from nine different points of view. By comparing the form of the orthographic plan to that of a square, and the perspective to that of a cube, it can be readily ascertained from the various views of the cube what will be a desirable point of view for the perspective that is to be drawn.

Take for instance an edifice that is rectangular in plan, having the dimensions of one hundred and fifty feet frontage on an important street, and forty feet frontage on a street of lesser importance. The front on the important street should show in perspective a near approach to a full view,

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and the narrower front allowed to vanish rather rapidly, and angle of view of about twenty-seventy would be preferable. Should the narrow front be the important facade, then the long side should be permitted to vanish rapidly, and near approach to a full view of this facade should be obtained, the angle of view for this perspective should be about forty-fifty or twenty-five - sixty-five. Should the orthographic plan be a rectangle, and the plot of ground an inside lot, with one important facade on the street front, this should be shown in a perspective full view, and the long side on the party wall line, allowed to vanish rapidly, an angle of view of ten-eighty would give the most desirable point of view. Should the orthographic plan be close approach to that of a square, with two facades of equal importance, then we should consider the edifice as a cubical block. A good view of the edifice can be had at an angle of view of forty-five, forty-five, but this would allow all the returning mouldings, in the cornice and belt courses, to mitre in a straight line, without a profile to the mouldings, at the corner of the edifice, if the intersection is a right angle and is not rounded off or ornamented; though this is not detrimental, and perhaps would not be noticed, if it were not called to attention; however, this sort of thing can be obviated, the returning moulding given the desired profile, by taking the angle of view at twenty-five, sixty-five or forty-fifty. By comparing the form of the orthographic plan to that of a square, and then considering it in perspective as a cubical mass, it can be readily seen from the different views of the cube, on this plate, what will be a desirable view for the perspective of the edifice.

Perspectives of an interior should be considered from a different viewpoint than that of an exterior. A perspective of the exterior of an edifice conveys an impression to the mind that something is advancing toward the observer or is drawn out for his inspection; whereas that of an interior gives the opposite impression to that of an exterior view. The objects in a room appear as though they were moving toward a point farthest from the eye, wherein the greater length of the room will appreciably increase this aspect and can be compared to a view looking down a street. The buildings paralleling the sides of the street are the side walls, the street paving, the floor of the room and the open sky representing the ceiling, we then have a view of a room with an indefinite length.

Perspectives of interiors are usually drawn in parallel perspective. However, a perspective drawn of an interior by this method and compared to a photograph taken from the same point of view would never appear quite the same, as the photograph would show a convergence to the parallel lines, on the three sides of the room, whereas an interior drawn in parallel perspective, the far end of the room would be a rectangle in which the vertical lines intersected with the horizontal at right angles; as in angular perspective, the points of intersection are at oblique angles. A comparison of the two methods of perspective delineation for interior perspectives is

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given on *Plates Nos. 6 and 7*. On *Plate No. 33* is illustrated the same method for the delineation of an interior perspective as for that of an exterior. *Plate No. 32*. Taking a rectangular room as a basis, with the plane of the picture crossing the center of the room, a view showing the three walls of the room would be drawn at an angle of view of ten-eighty; a room of which two walls are shown in the perspective, and one has an important motive, or wall decoration, that will be seen in the perspective, a better view of this motive can be had by changing the angle of view, say thirty-sixty, or if on the other side of the center line of the semi-circle, an angle of view of sixty-thirty. If one corner of the room is all that is to be shown in an interior perspective, and both walls have equally important wall decorations, a view at an angle of forty-fifty, or forty-five - forty-five will give the view desired.

Picturesque Perspective

THE accompanying sketch block perspectives illustrate to what extent the principles of perspective can be utilized in the delineation of picturesque groups of buildings. Heretofore we have considered the perspective of an edifice which is treated as an individual unit, with its accessories, and not as a group collectively. A large proportion of the delineators commissions will be of that nature, except when a bird's-eye perspective of a group of buildings is to be used collectively, but erected as individual units, on a large plot of ground. For the most part these block perspectives, are accompanied by a perspective in plan, of the group drawn to a smaller scale to show the method of arriving at these results.

The relative importance attached to the position "C", which is in a direct line with the station point, and about which the picture plane is rotated should not be considered as a coincidence, as a step forward or backward, to the left or to the right, would change the point of view in its entirety.

The first sketch on *Plate No. 33* shows a building erected on an irregular plot of ground, formed by the intersection of two streets, and terminating in a plaza. The important facade fronts on the plaza, the horizontal lines in the composition of the motives, on this facade, having no vanishing point, but connect the ends of the termination horizontal lines, in the composition of the motives, on the two other facades. This sketch is drawn at an angle of forty-five degrees, and is accompanied by a perspective in plan on *Plate No. 34*. Compare with the sketches on *Plates Nos. 21 and 22*.

A rise or drop in the grade line of a city street where the buildings rise perpendicularly on the building line, these different levels will often present a confusing problem to the delineator, when it is to be shown in perspective. The drop in the street grade, in the second sketch on *Plate No. 33*, is twelve feet, in one hundred and thirty-six feet, this depth

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should be measured below the starting point, and projected to an established point on the edifice. The vanishing point for all lines that parallel this drop in the street grade, is found by measuring down in a vertical line, on the line representing the position C, the depth below the grade, and at the point of intersection of a line, drawn from this point, to a point, in the street below, then continued to the vanishing points; a line drawn from C on the sidewalk level to intersect the point just found, and continued to a line drawn through the plane of the vanishing point, will establish the vanishing point, for all lines that parallel this drop in the street grade.

With reference to what has been said heretofore, regarding the point of view, in the third sketch on *Plate No. 33* is a row of buildings; fronting on an open space, drawn at an angle of view of twenty-five, sixty-five, as compared with a similar group on *Plate No. 39*, drawn at an angle of forty-fifty. The first mentioned sketch drawn at an angle of twenty-five, sixty-five, gives a view that contains little of interest, as it apparently has no stopping place, and the eye wanders along from one to another, finding nothing of interest until they vanish at infinity on the horizon. As in the second mentioned sketch, each member of the group attracts the attention, on account of their individuality, and pronounced character. In all perspective delineation, the point of view should be considered of paramount importance, as on it depends whether the attention is to be concentrated, on a group of motives of particular interest, or is to be led away from the picture by the flow of line, that makes up the composition of the group.

The possibility of taking advantage of the natural topography, in cities that are built on the sides of terraced hills, this sketch furnishes a good example of what will be often met with in perspective delineation. The stepped ramp rising above the street level, to the elevated terrace, allowing the lower portion of the building to be used for quarters and shops, with apartments above them. The method of obtaining the position of the vanishing points, for the parallel lines in the stepped ramp, and those that parallel the slope in the grade, are illustrated in the first sketch on *Plate No. 35*.

This street scene, portrays a rather unusual subject to be delineated in perspective, scenes of this character are usually drawn by parallel perspective, in this instance the angle of view is ten-eighty, giving a view of both sides of the street. The converging lines in the composition of the edifices, on the left and right hand sides of the street, pass beyond the plane of the vanishing point, and continue to rise until they pass beyond the plane of the picture. This is not a coincidence, as it will be apparent in all scenes of this character, in which some part of the assembled group, lies in front of the picture plane, and another portion in back of it, which forms the termination of the street, (compare this with the street scene *Plate No. 8*, in which the street is crossed by an elevated railway) and

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the parallel horizontal lines converging to a vanishing point. The position of C is located in the center of the lamp-post, as shown by the perspective in plan on *Plate No. 36*.

Methods of drawing arches and vaulting in perspective, are usually illustrated by orthographic projection, although a mechanical process, it is perhaps the best method of drawing them, if absolute accuracy is desired; on the other hand, they appear about right, when drawn freehand, as the mechanically drawn arch, would not harmonize with the freeness of the surroundings. A series of arches around a court yard, are illustrated in the third sketch on *Plate No. 35* drawn in angular perspective.

The irregular plan of the dwellings and the garden wall, with the sidewalk following the contour of the canal, in the first sketch on *Plate No. 37*, requires locating a series of vanishing points, in a vertical plane, above and below the horizon, for the delineation of this sketch in perspective. The sketch is drawn at an angle of twenty-seven degrees, owing to the large number of obtuse angles, in the irregular planning, it requires a vanishing point, for each system of parallel lines in the perspective in plan, as well as in the perspective. Although there was no real necessity, for this method of delineation, as with a few exceptions, all the obtuse angles could have been drawn as right-angles, and this alteration would not be perceptible, in the picture; but to be exact, and to follow out the true form of the irregular plan, the position of the various vanishing points were found, for the perspective in plan and for the perspective.

A group in which each unit will hold the attention for a period of time, is illustrated in the second sketch on *Plate No. 37* as the units are considered individually, there will always be something in reserve to attract the attention. The thoroughfare leading out of the picture, does not carry with it the point of interest, as it is interrupted at the junction point of the two streets, and the eye will always follow the triangular course, bringing it back to the starting point. This sketch is drawn at an angle of forty-fifty degrees, with a perspective in plan on *Plate No. 38* showing the position of C.

In the third sketch on *Plate No. 37* there can be no obvious reason given for this method of delineation, other than that, it was an attempt to produce a perspective, that would apparently be distorted from this point of view; in this sketch the remote corner of the building being farthest from the eye, and in a direct line with the station point, is drawn as though it was closest to the eye, allowing the picture plane to cut through the edifice back of the facade, that is to be delineated in perspective; requiring the projection of all points, laid off on the measuring line, to the picture plane lying in front of this line, instead of back of it, as in the usual method of delineation. In reality the opposite corner of the edifice farthest from the corner on which the vertical heights are laid off to scale measurements, and the diverging parallel lines in the motives

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to this point, would be rather diffused, as they pass beyond the plane of vision, if they were drawn as they would appear in actual projection, and not altered somewhat, they would be slightly distorted. As in this instance, the height of the edifice is about equal to that of a two story building, so the distorted form of the motives, was easily remedied; however in an edifice of greater height, it is hardly possible that it could be as easily corrected, therefore this method of perspective delineation is not to be recommended.

The first illustration on *Plate No. 39* shows a group of buildings in block perspective, erected on the side and top of a low spreading hill, bordering on a small river. The view is drawn at an angle of twenty-five, sixty-five degrees, showing the position of the horizon and the ground line. The station point, is in a direct line with the position C, and the intersecting part of the sketch, lies back of the bridge spanning the river, with the picture plane cutting diagonally through this bridge.

The average person viewing an object, or group of objects, the level of their eye would be from four feet, six inches to five feet, above the earth's plane which will be the horizon line. The delineator should be consistent in placing the height of the horizon above the earth's plane, and take in consideration the height of the eye of the average person, so as not to place it at a level from which the least number of persons will view the object.

The second illustration on this page, shows a group of buildings sketched in block perspective, paralleling a street with the horizon line about the level of the eye of the average individual, which is the opposite to that of third illustration on this plate, in which the observer is at a height above the earth's plane. Delineators are often given a commission to draw a perspective of this character, in which a group of buildings are spread over a large area, and one of the buildings will be of greater importance than the others. In order to see those of lesser importance in the background, as they are a unit of the whole group, the viewpoint is taken above the center of the whole group, at one corner of one of the more important buildings. The elevated position from which this group is viewed, should not be confused with what has been said, regarding the viewpoint of the average person, in this instance it is a conception of mass, to the extent it is proposed to erect additional buildings, to the group, in the near future, showing the various units spread over a large area.

Orthographic projection in perspective delineation is analogous to the surveying an irregular plot of ground, on the completion of the survey, by the surveyor, his line of traverse must close within a reasonable distance, without too great an allowance for the technical term "A personal Equation." The motive selected for illustrating the method of orthographic projection, in perspective delineation, is drawn on *Plate No. 40* taken from

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a perspective of the Masonic Temple, of Omaha, Neb., G. B. Prinz, Architect. It is essential, that accuracy should be the primary consideration in all orthographic projection, in the delineation of perspectives, as a very small margin is allowed the delineator, for looseness in his methods. To disregard this feature, the delineator will often experience considerable difficulty, in bringing the lines representing the returning mouldings, to close at the mitre points, without resorting to unnecessary work that would have otherwise been avoided.

The relative position of the minor motives, entering into the composition of this motive, with their relation to the building or property, as shown on this plate, are as follows: Taking the wall surface, around the openings as a basis, which is one foot and eleven inches from the building line, the face of the impost pilaster, is one foot and seven inches, from the building line, and the face of the large pilaster is eleven inches from the building line. The greater projection of the main cornice, is four feet beyond the face of the large pilaster. With these measurements as a basis, and measuring their height from an established point, and projecting the same to a line representing the center line of the large pilaster, in the plane of the building line, projecting the same point, back again to the center line of the large pilaster, it will give the required point in projection. The same method of projection, is used to obtain the profiles of the mouldings, in the main cornice and the other motives as illustrated on this plate.

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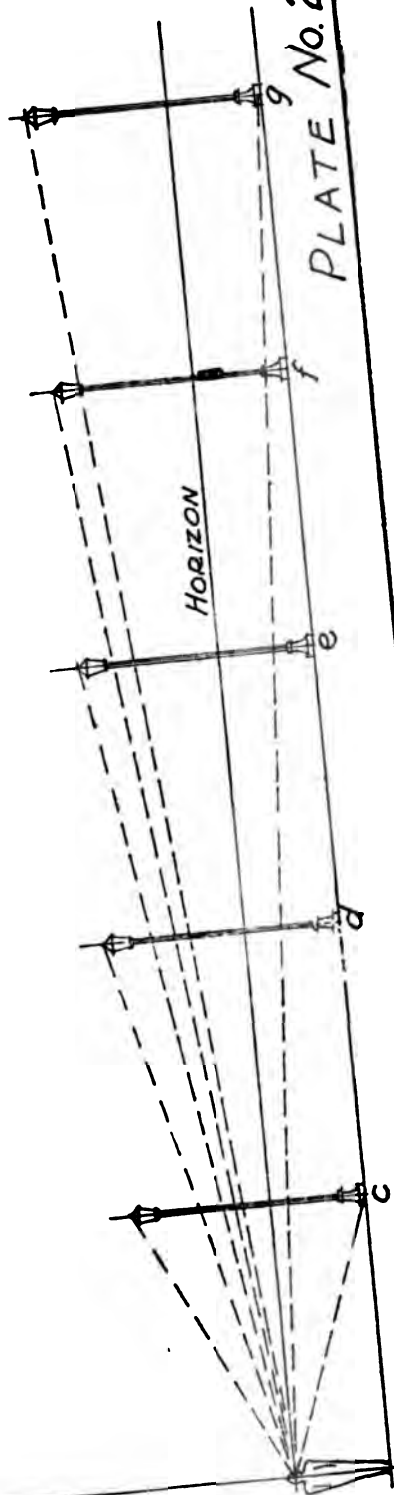
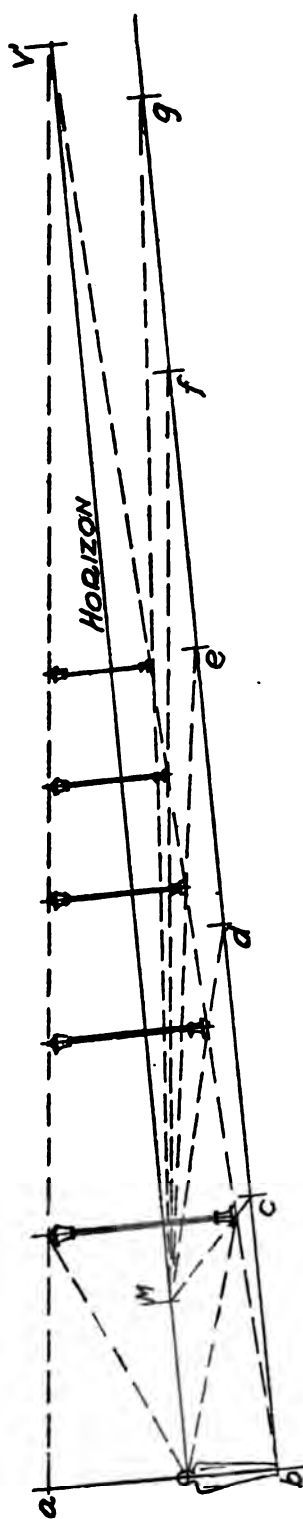
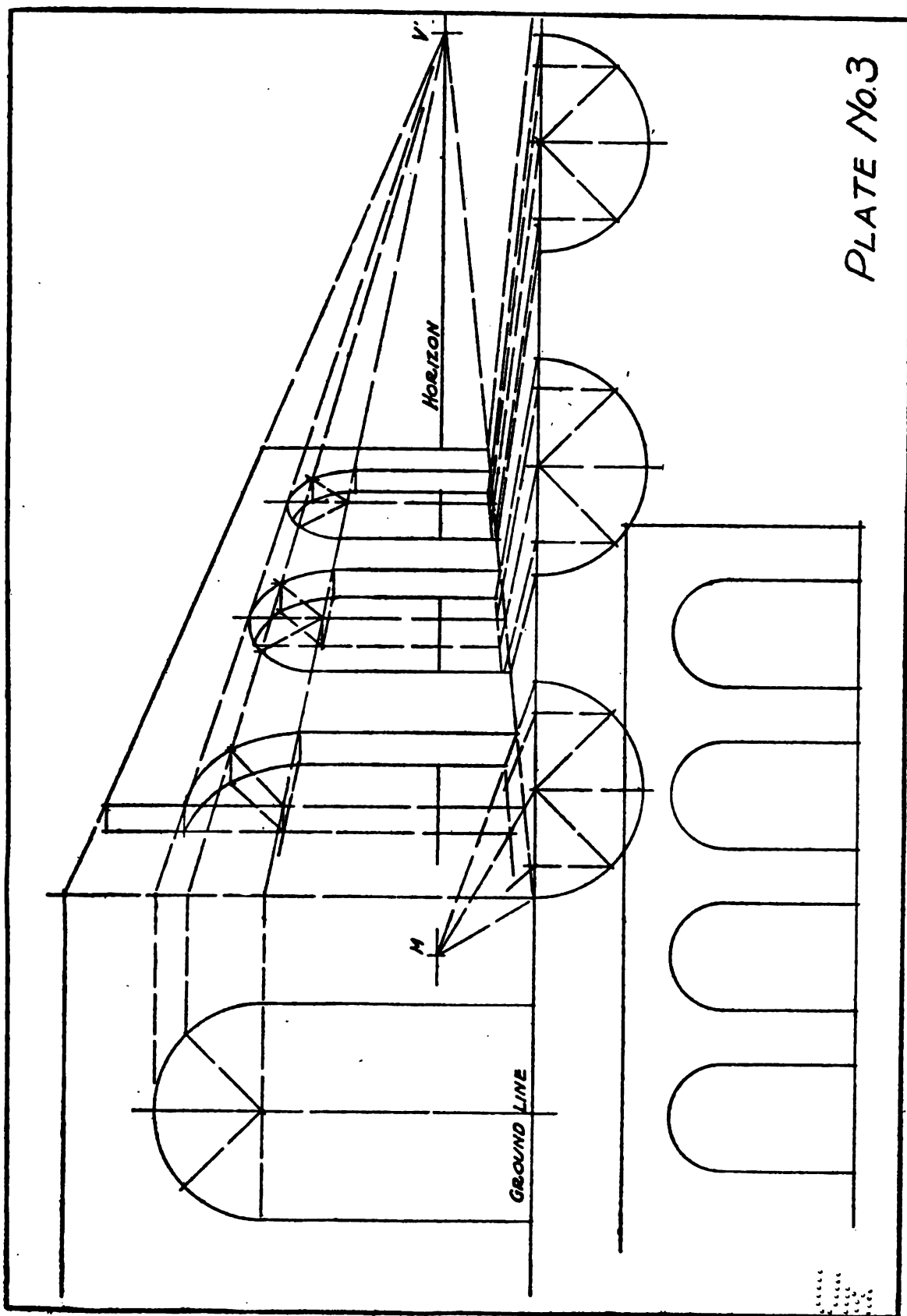


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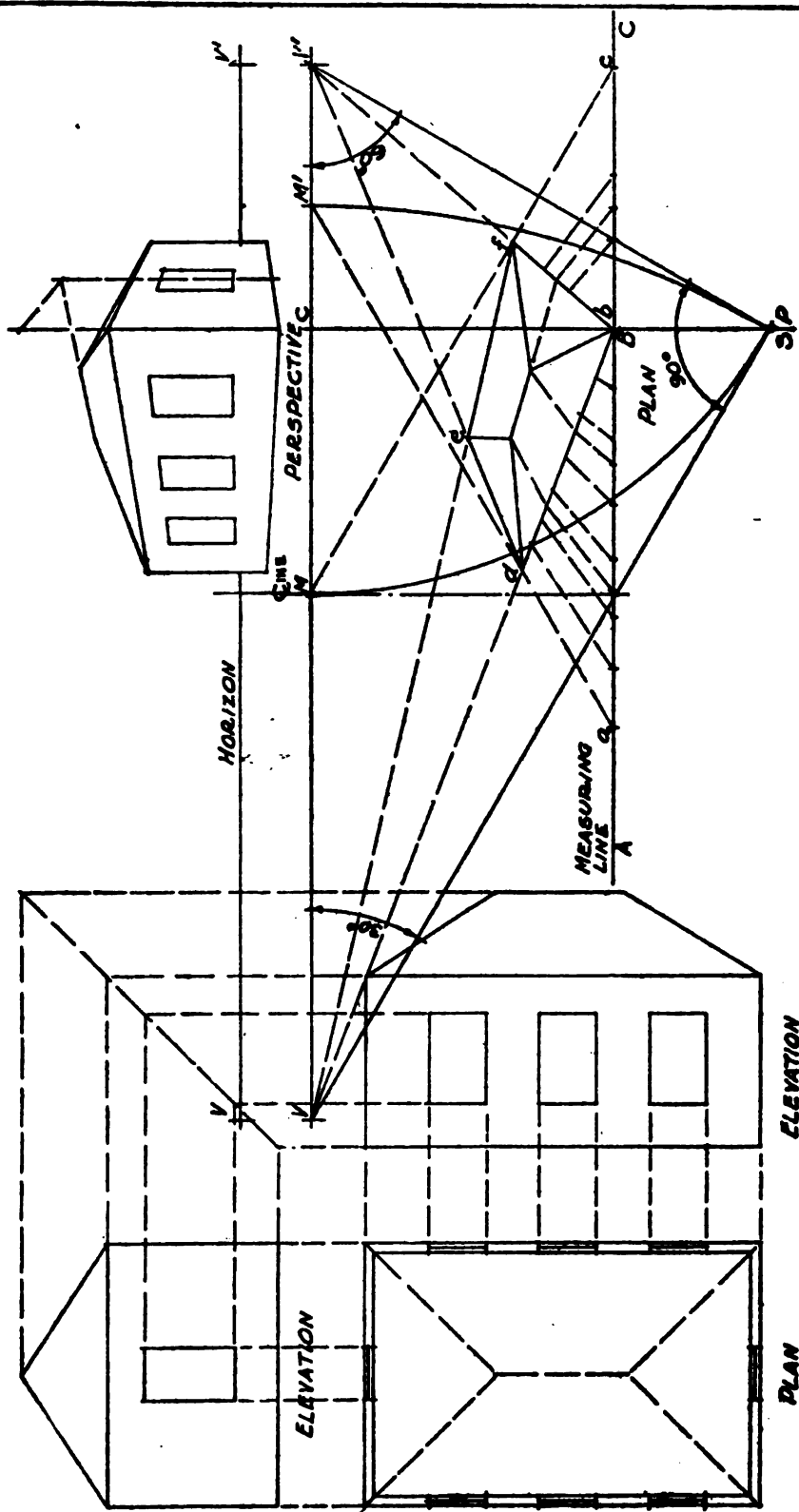
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PLATE No.5



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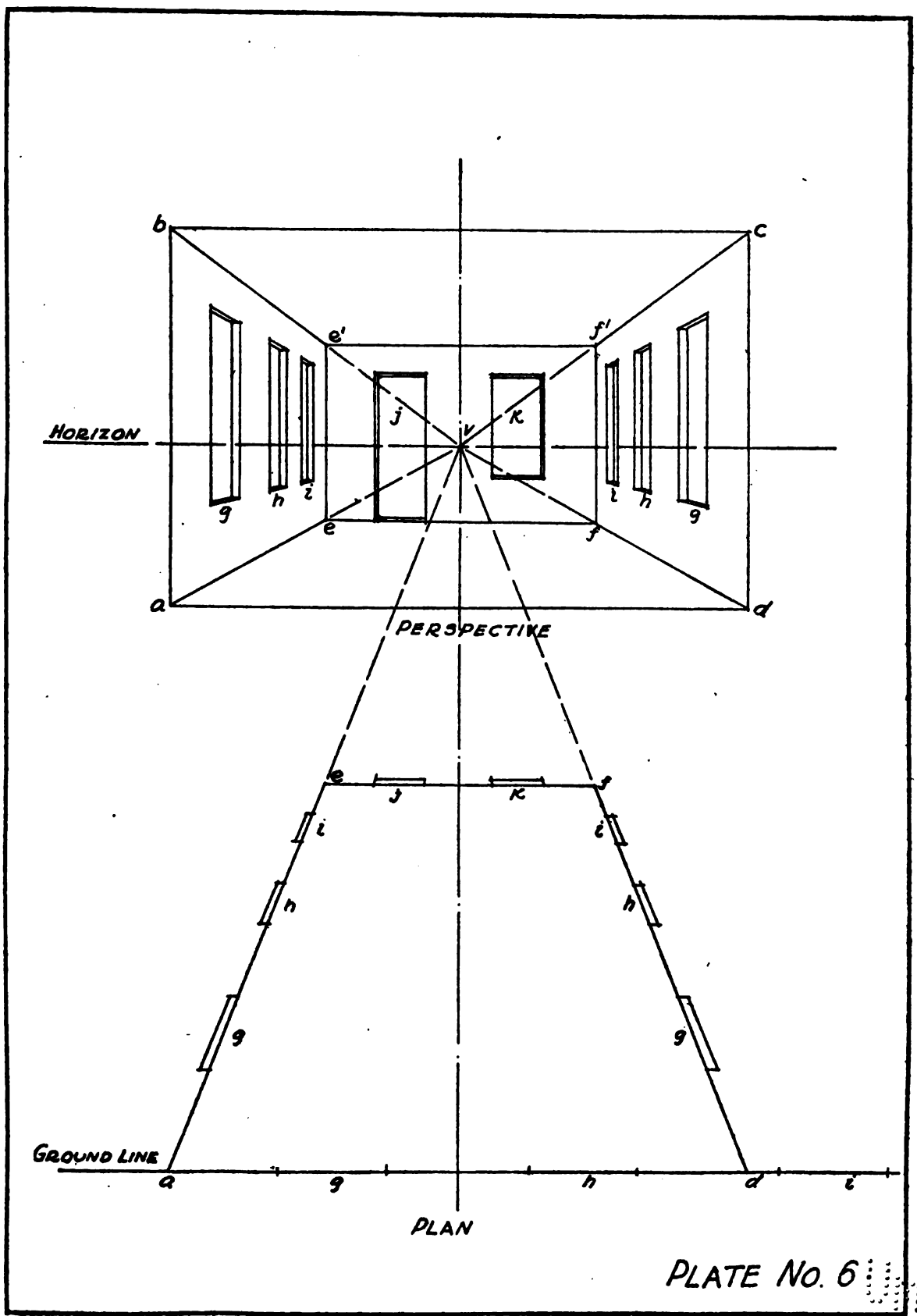


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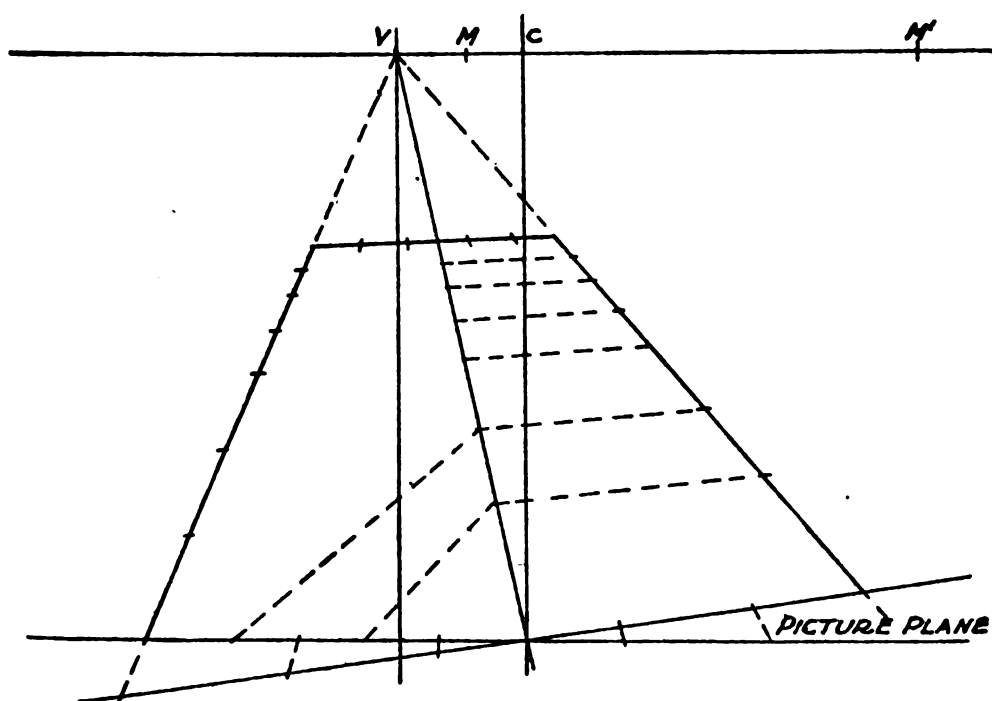
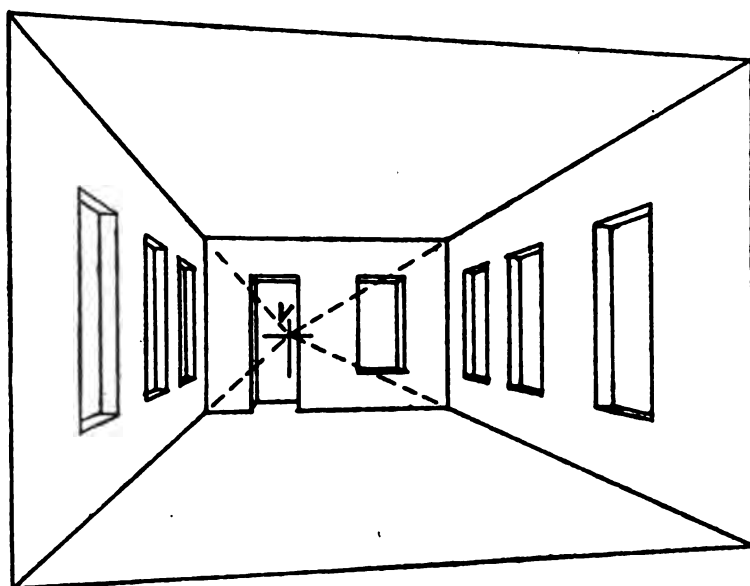
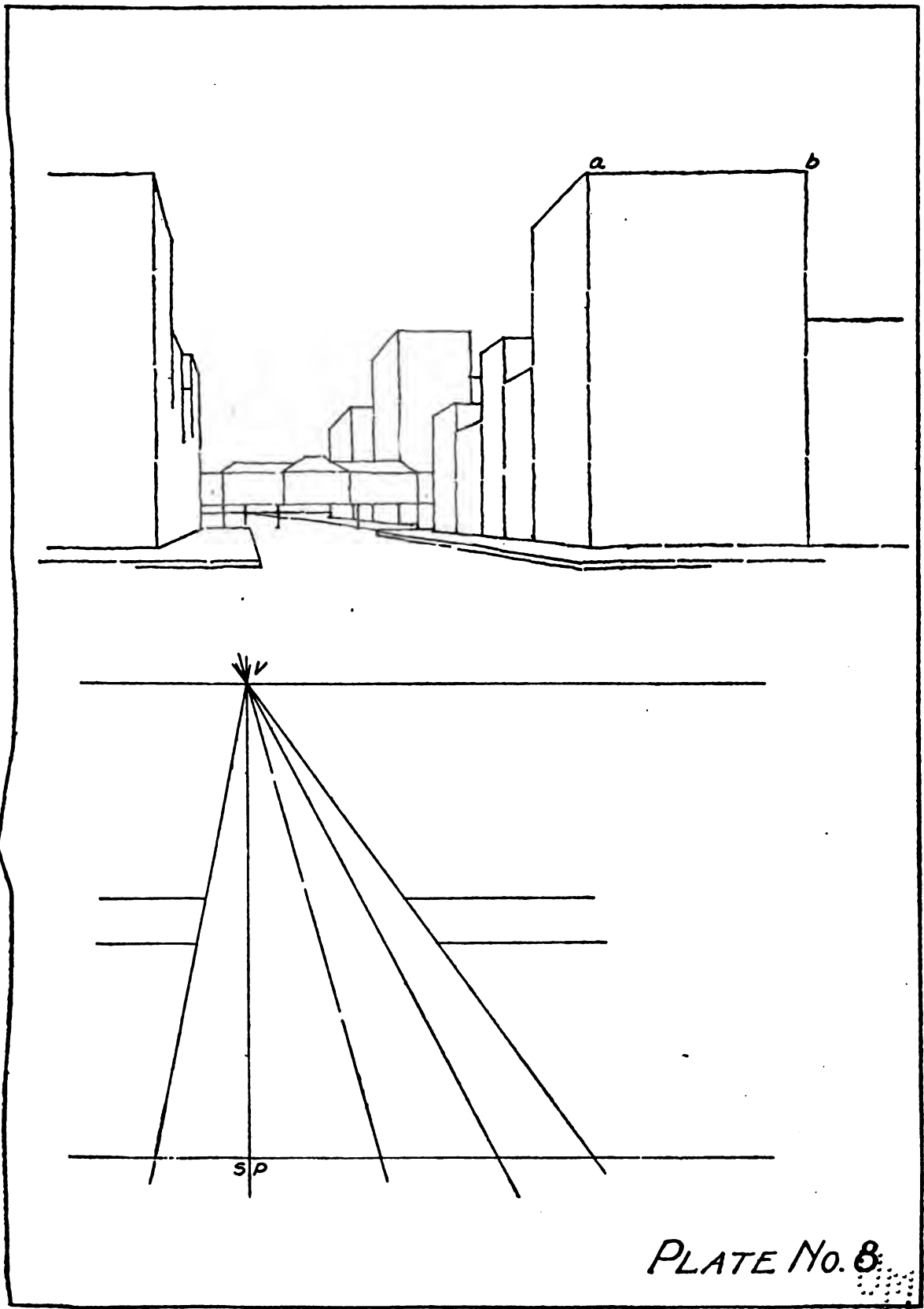


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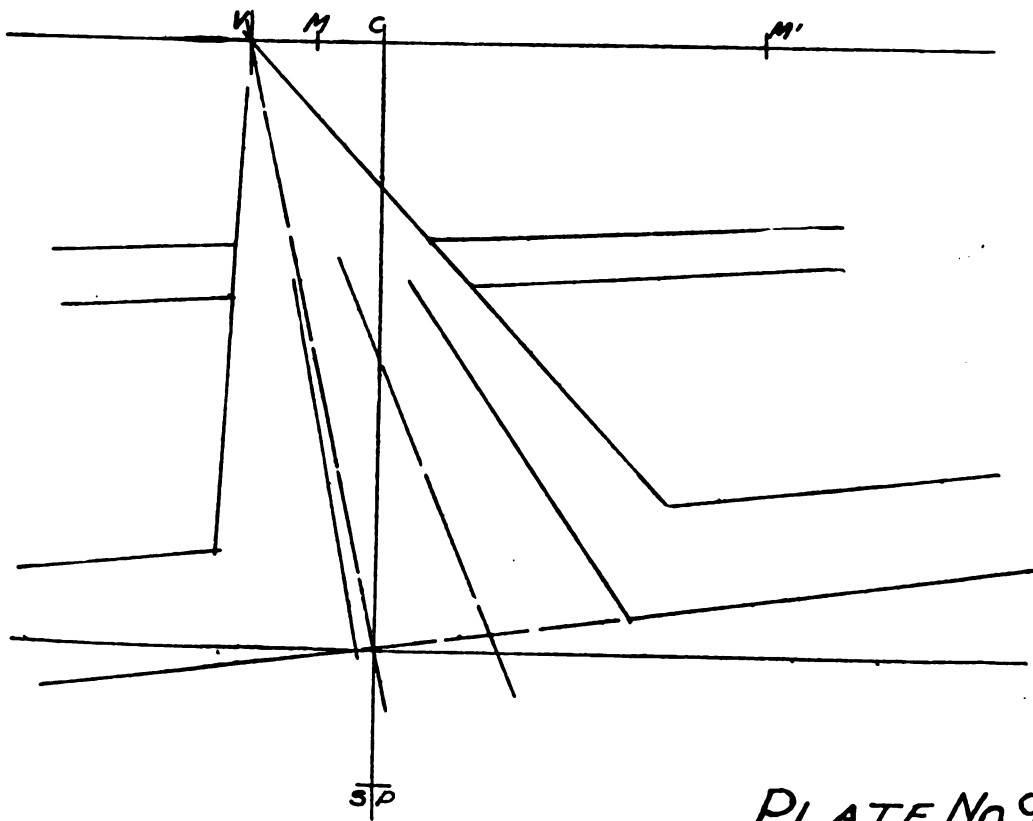
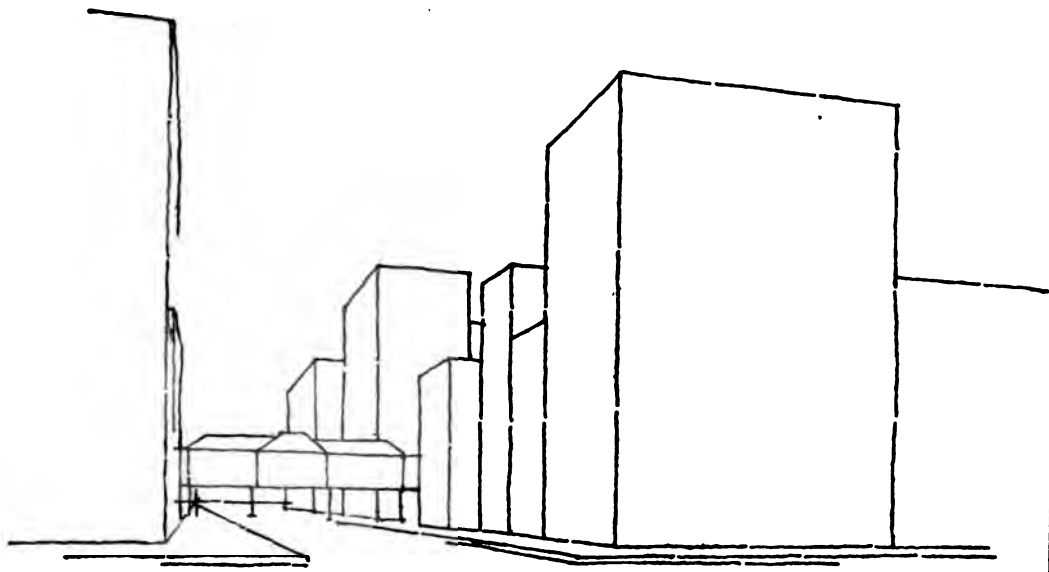
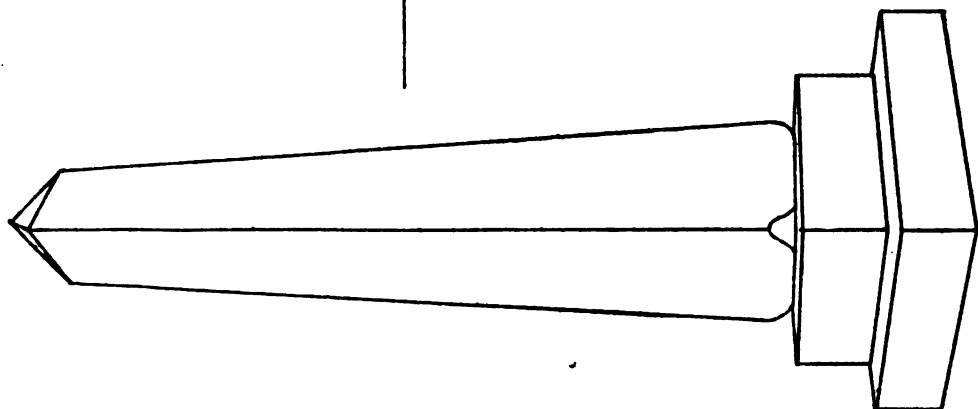
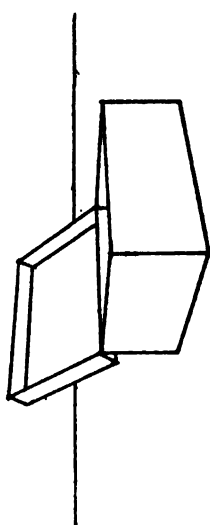
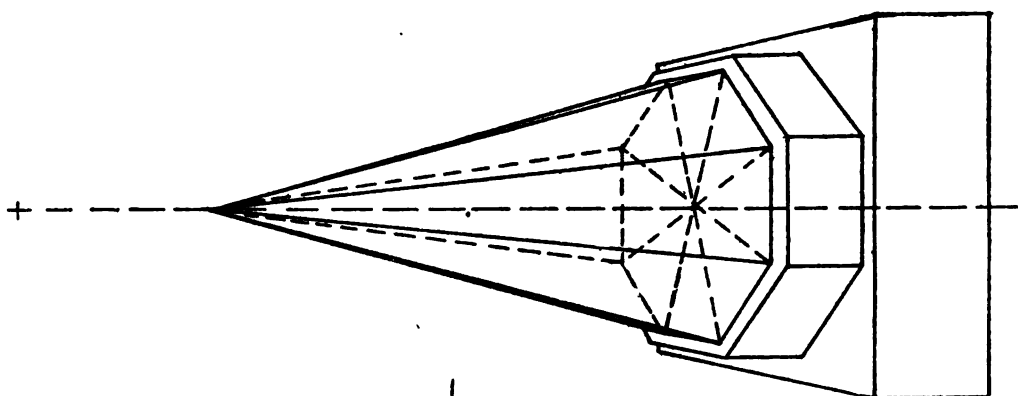


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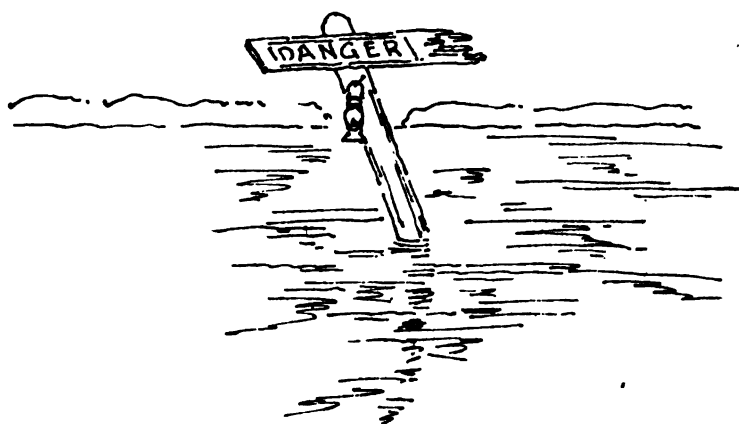
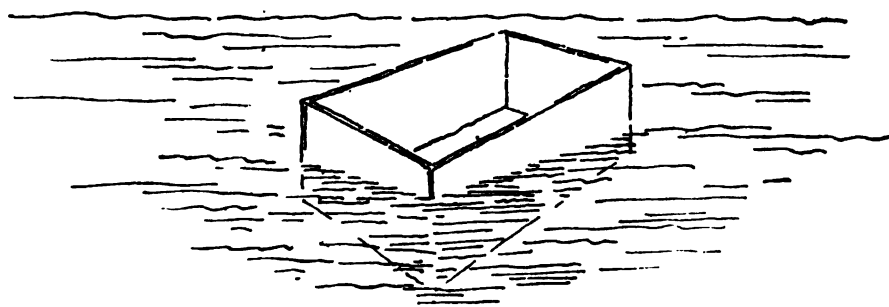
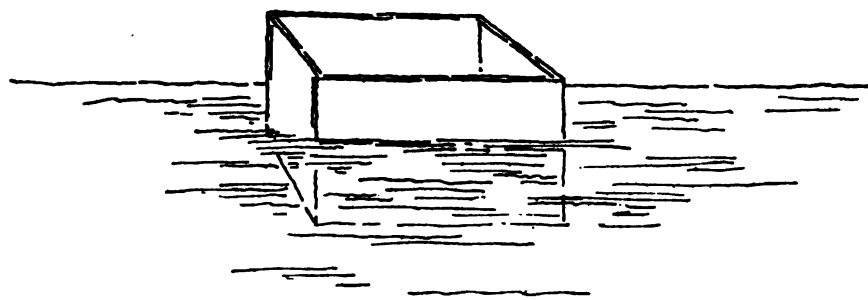


PLATE No 11

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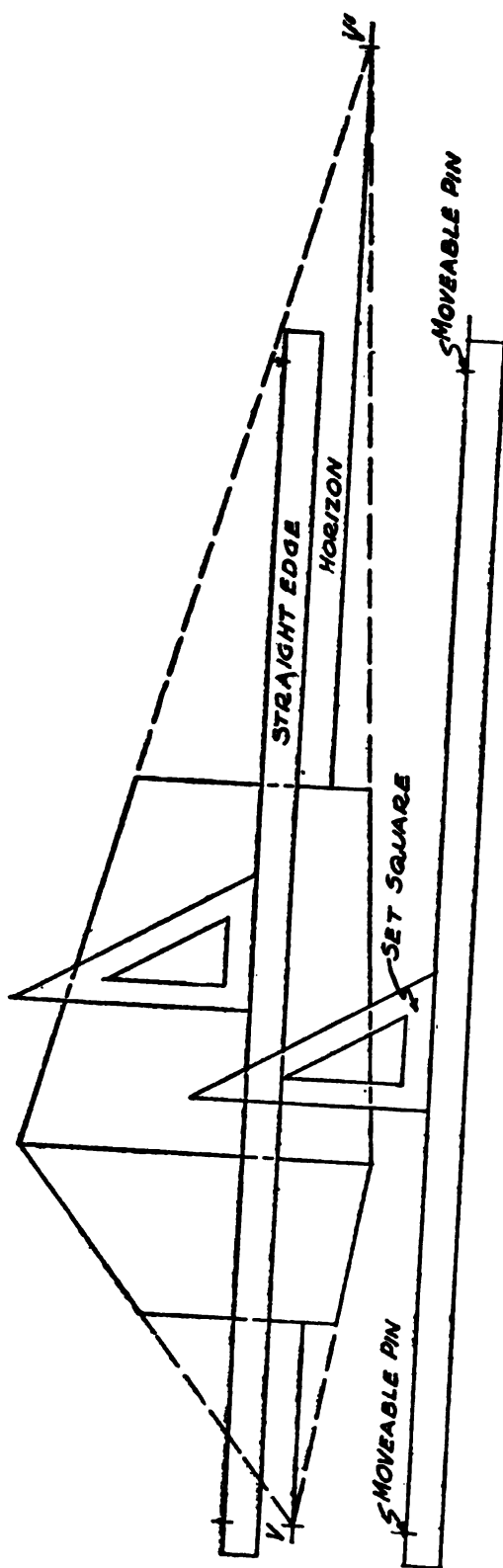
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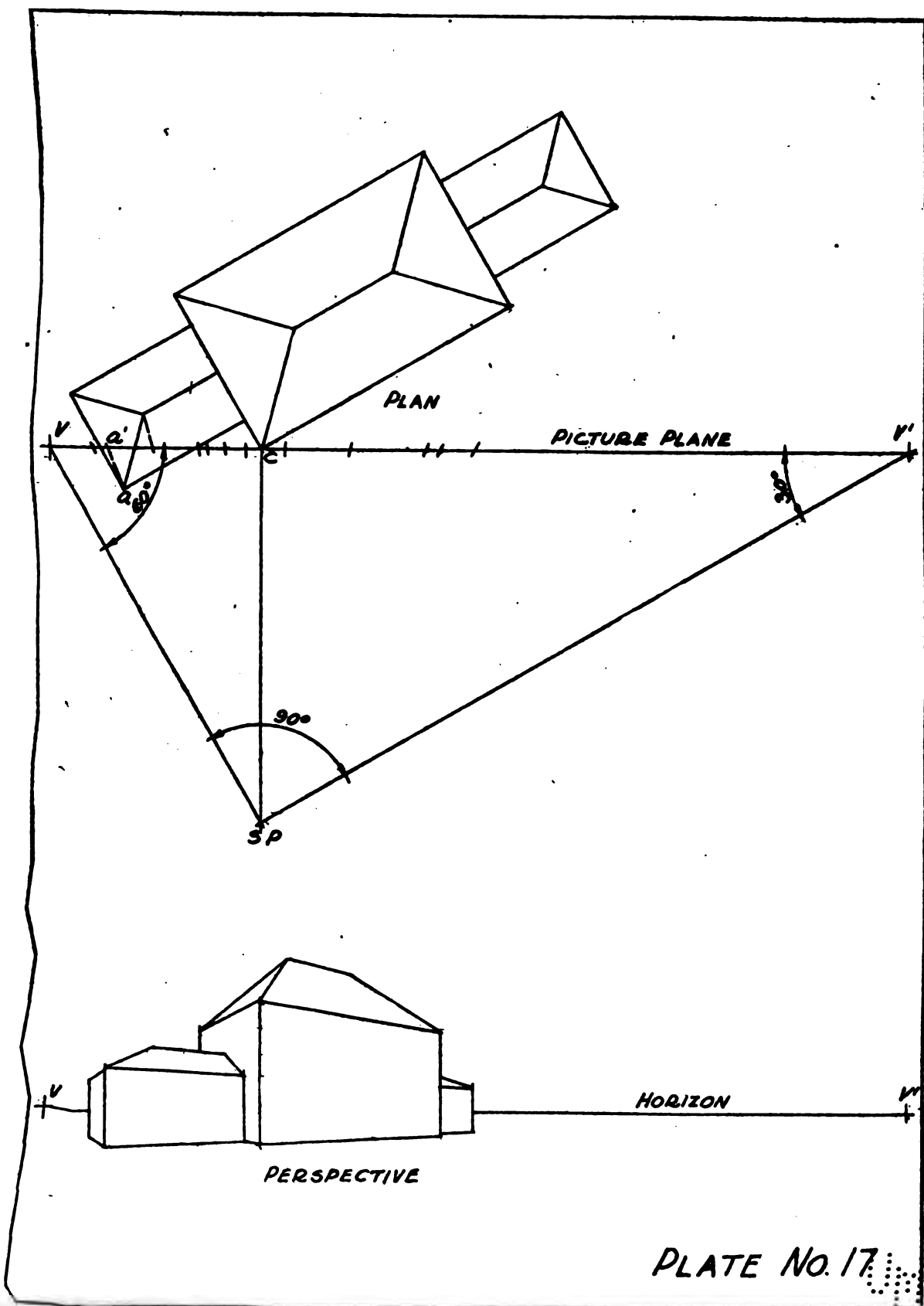
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PLATE No. 16



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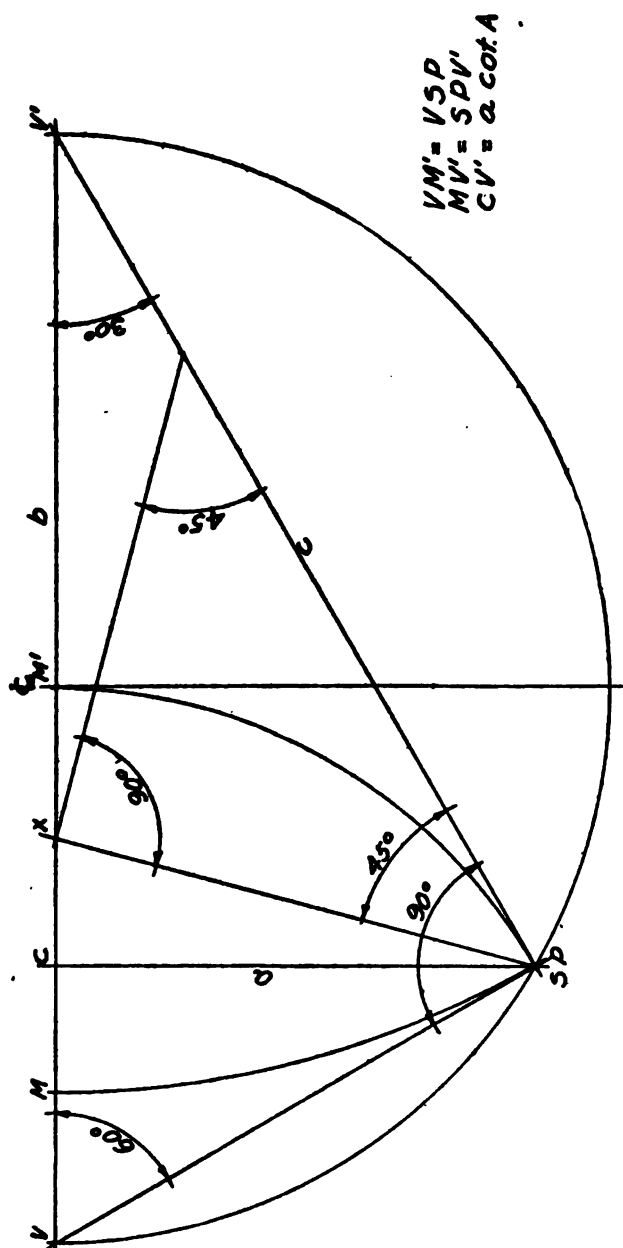
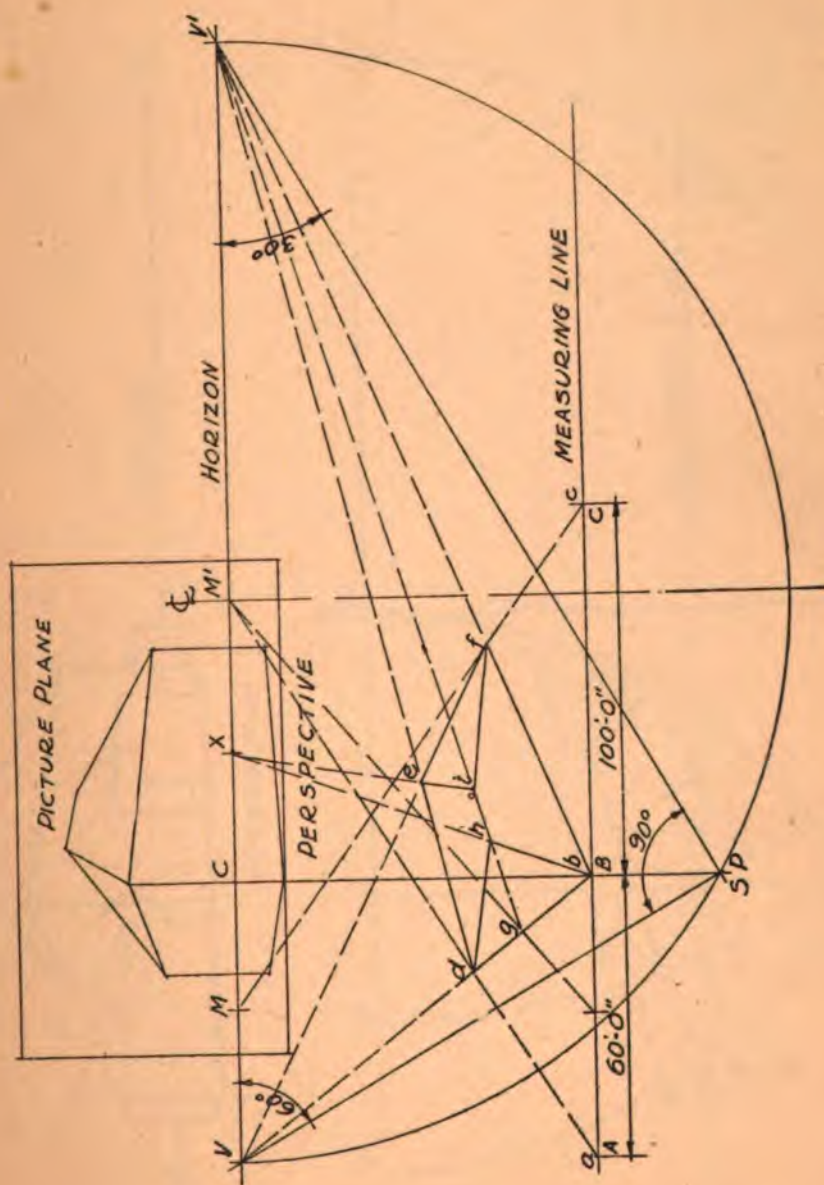


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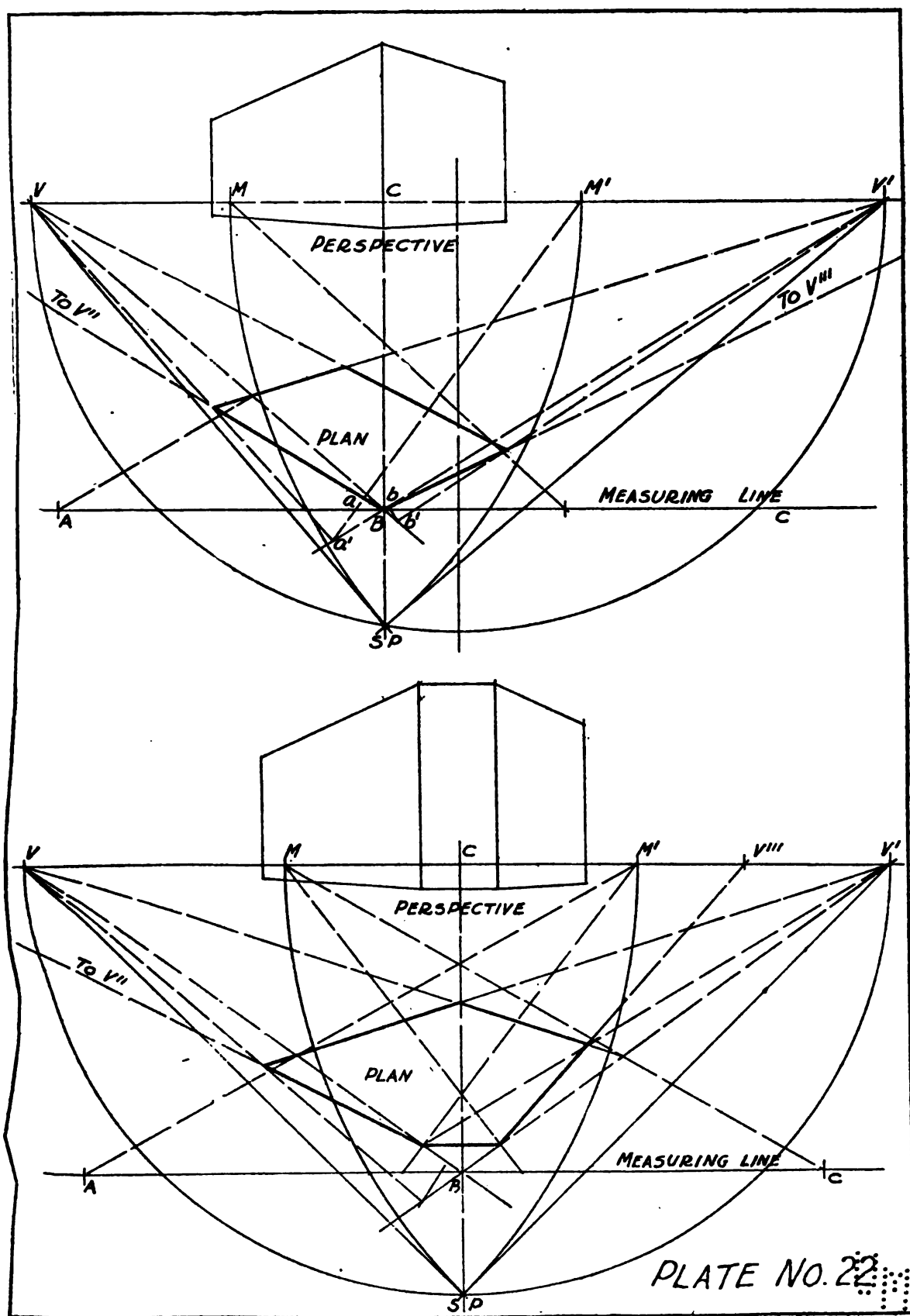


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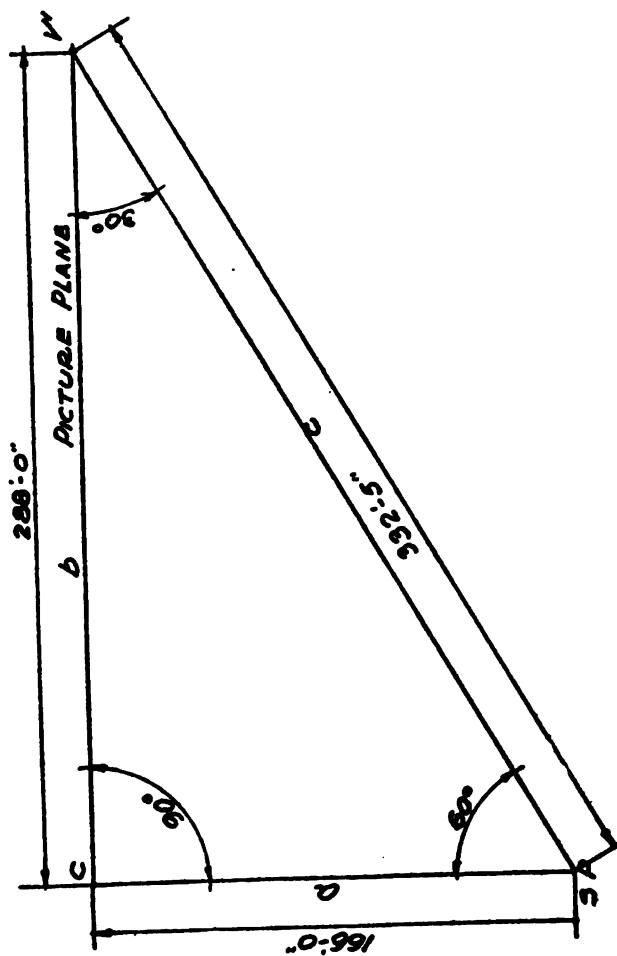
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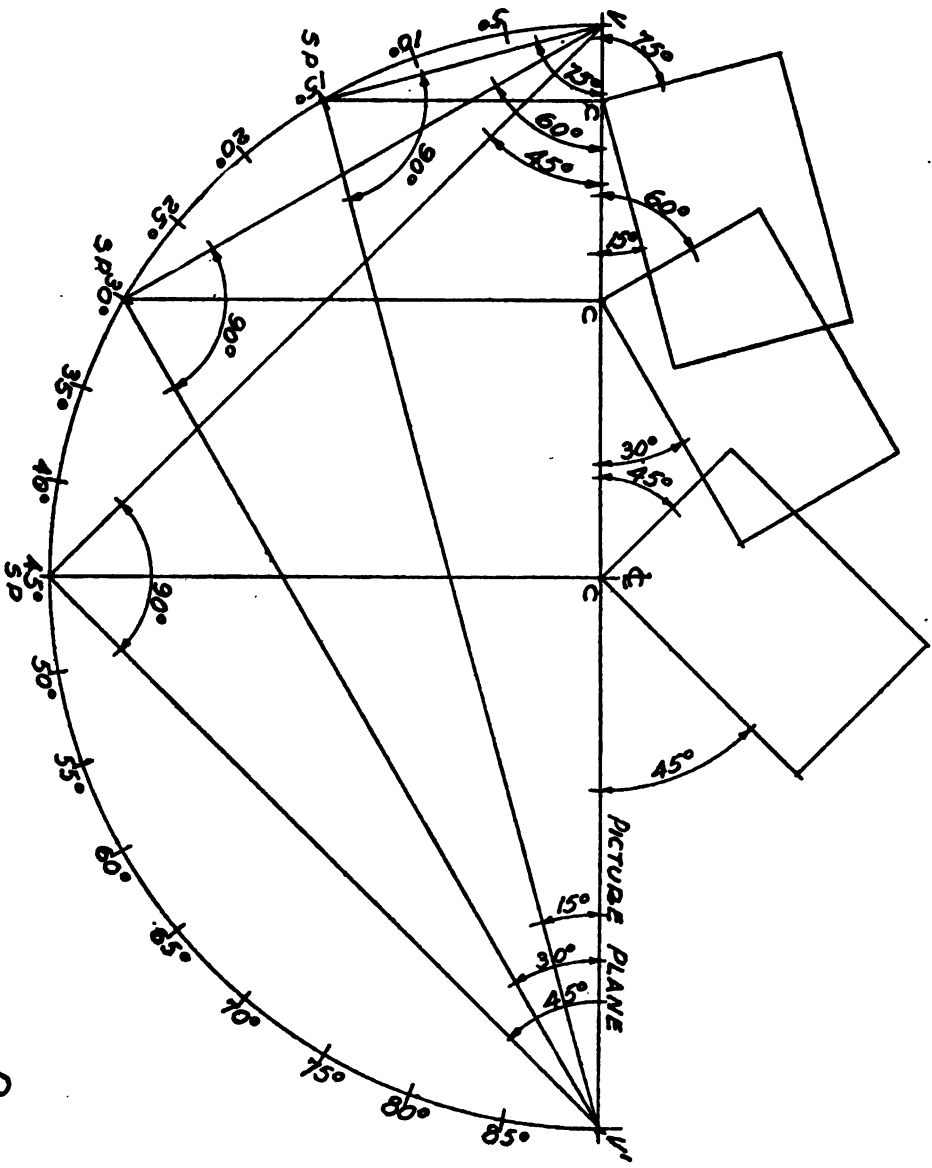
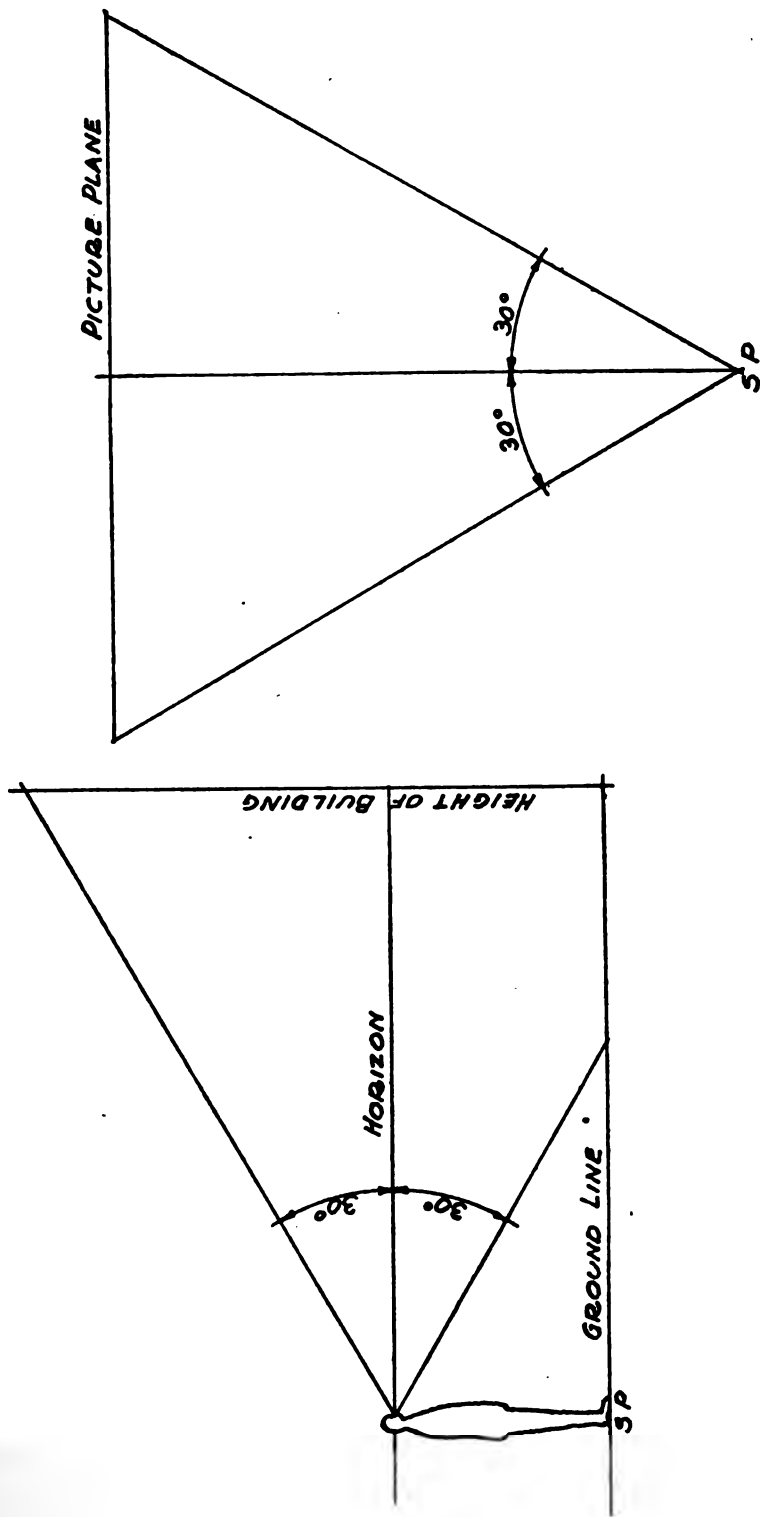


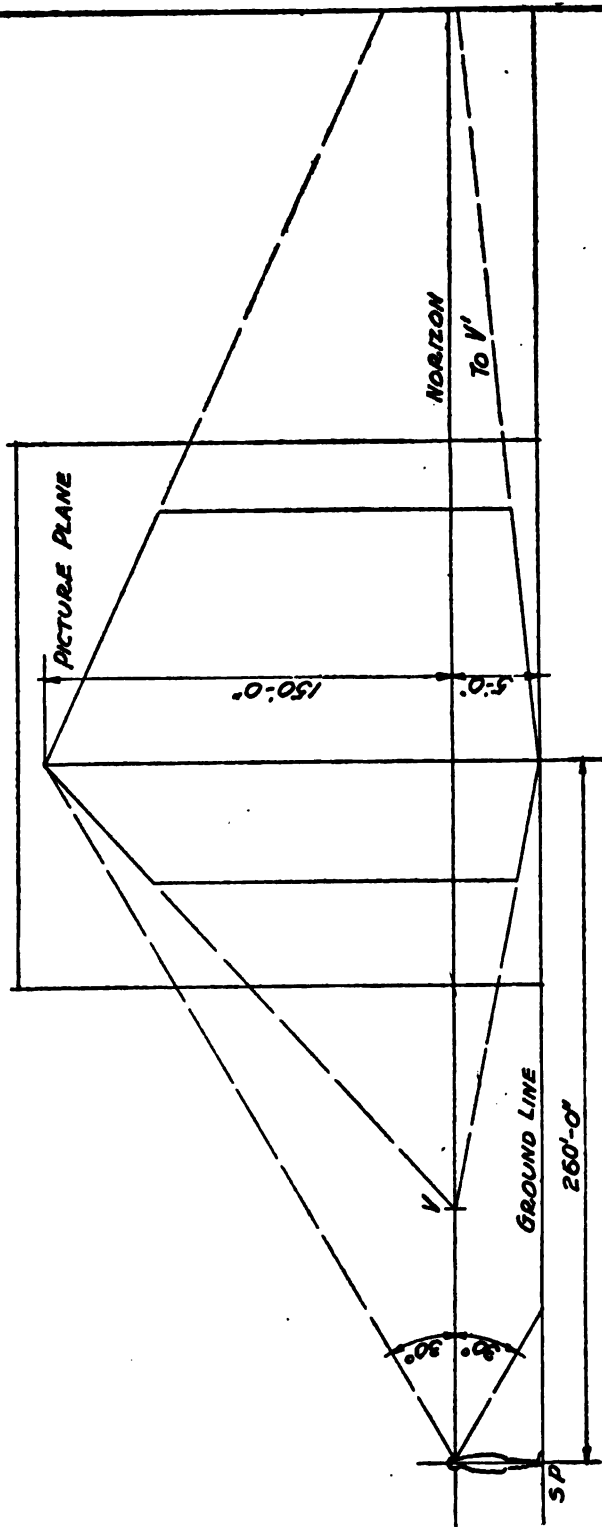
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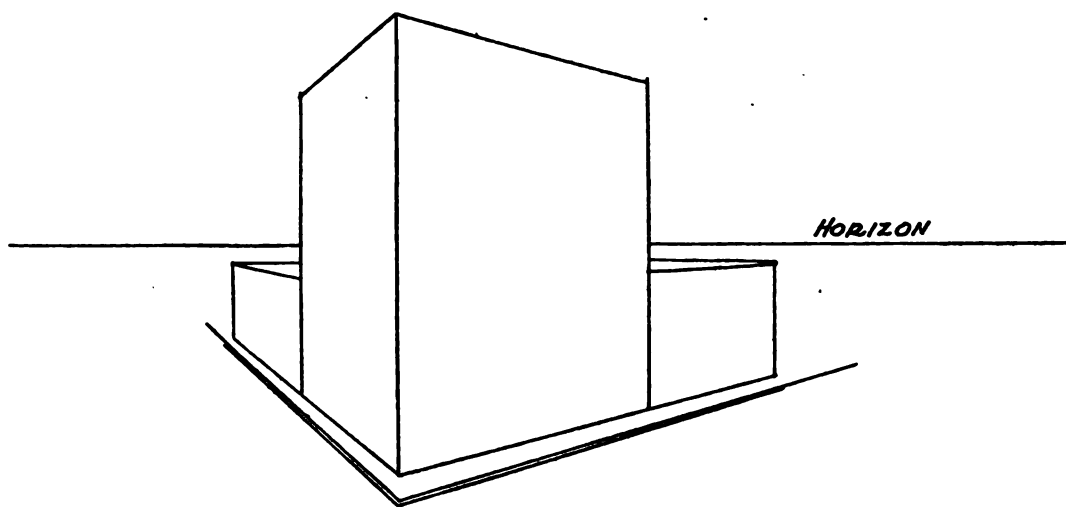


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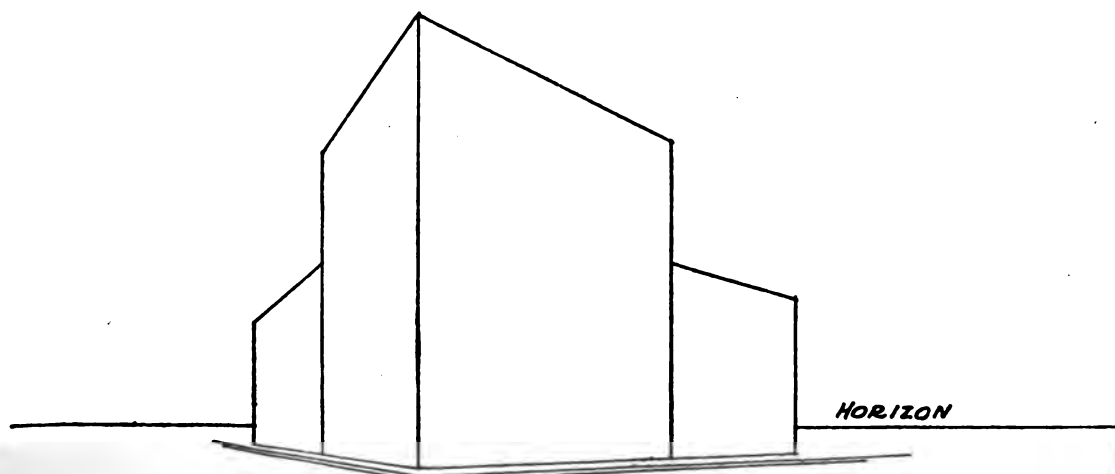
PLATE No. 26



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PERSPECTIVE



PERSPECTIVE

PLATE No. 27

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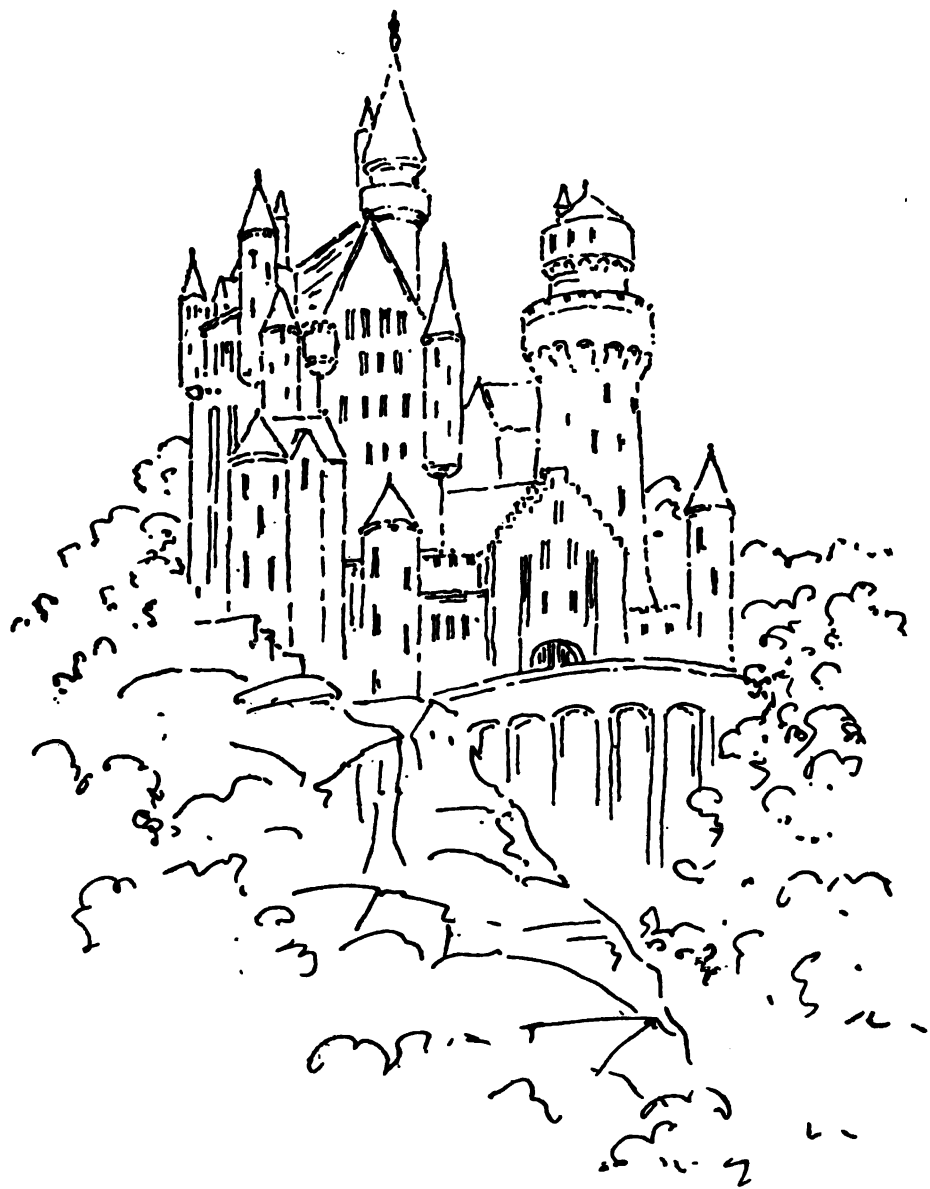
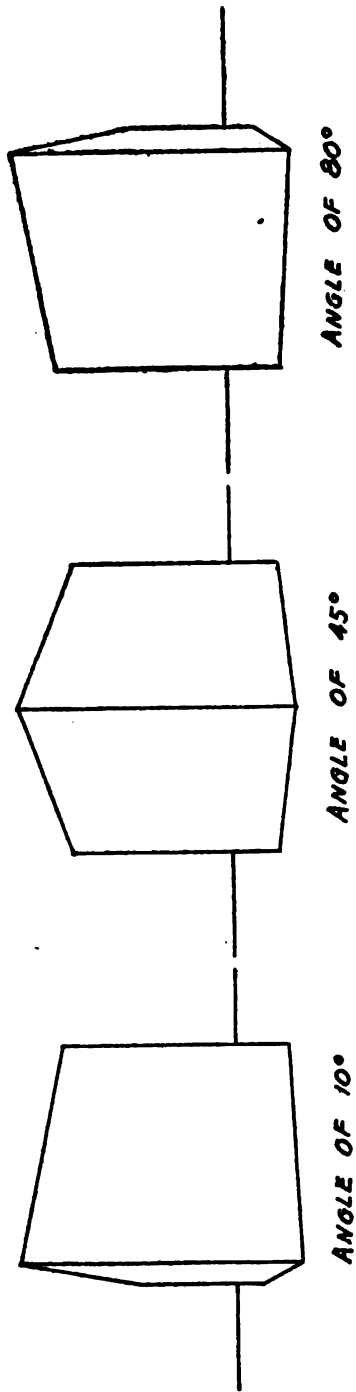


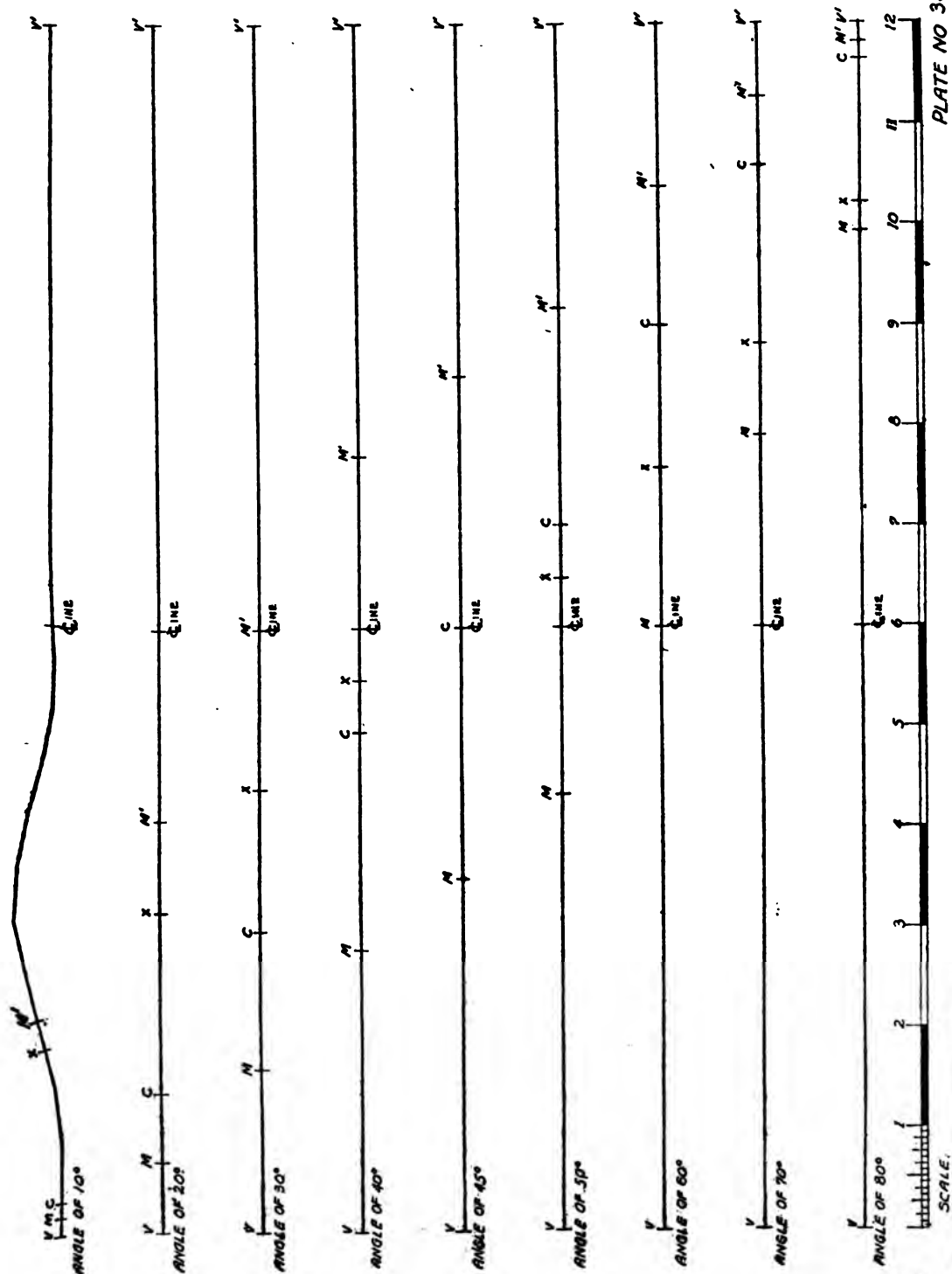
PLATE No 28

२५

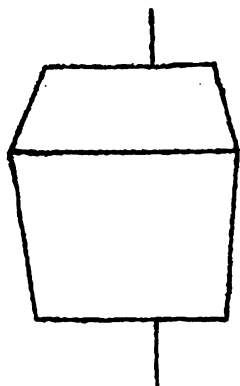


24

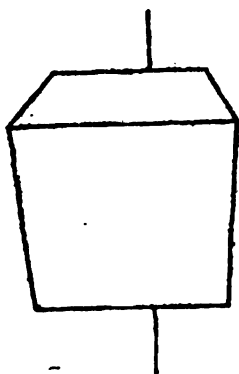
PERSPECTIVE SCALES FOR THE PERSPECTIVE IN-PLAN METHOD



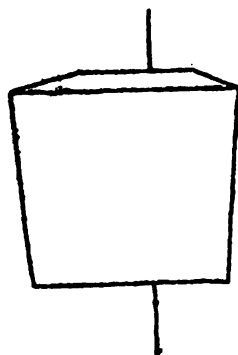
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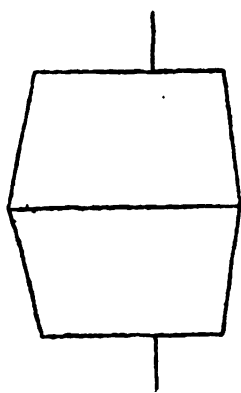
ANGLE OF 60°



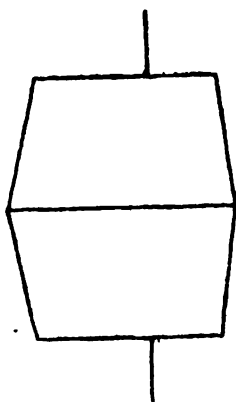
ANGLE OF 70°



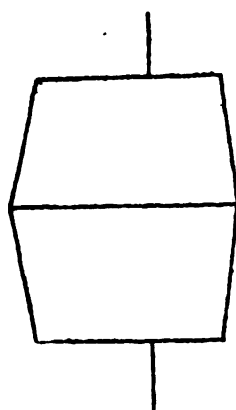
ANGLE OF 80°



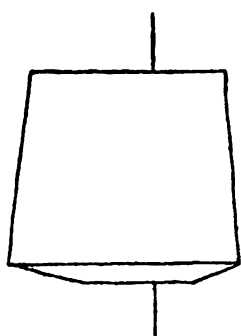
ANGLE OF 40°



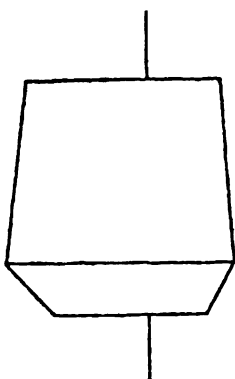
ANGLE OF 40°



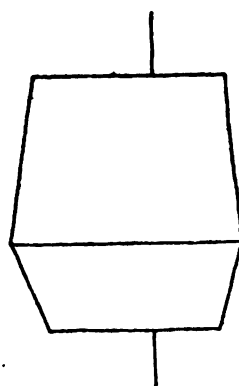
ANGLE OF 30°



ANGLE OF 10°



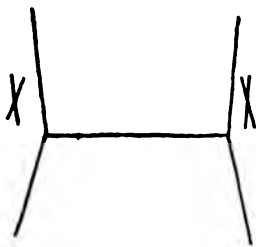
ANGLE OF 30°



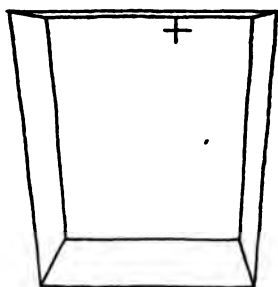
ANGLE OF 30°



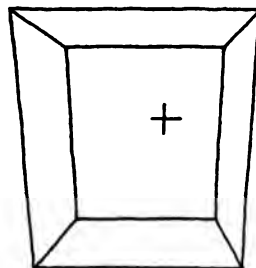
५५



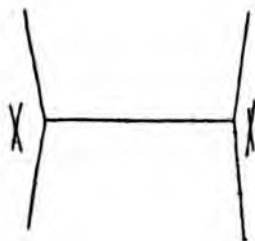
ANGLE OF 60°



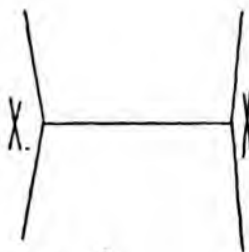
ANGLE OF 70°



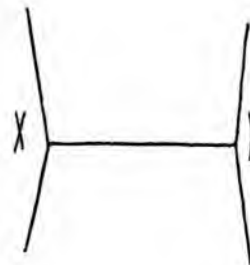
ANGLE OF 80° PLATE NO. 32



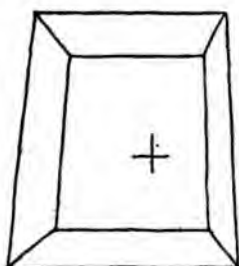
ANGLE OF 40°



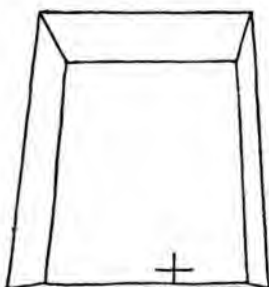
ANGLE OF 45°



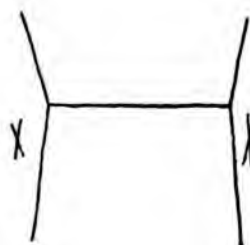
ANGLE OF 50°



ANGLE OF 10°



ANGLE OF 20°



ANGLE OF 30°



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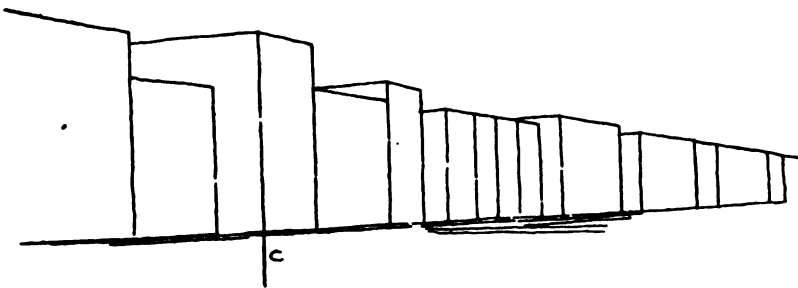
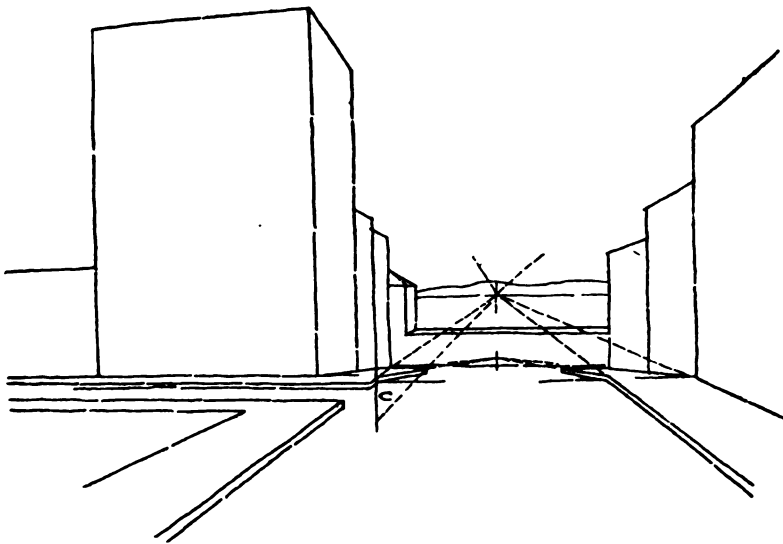
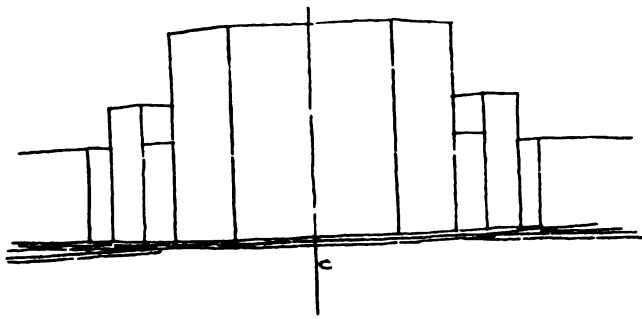


PLATE NO 33



24

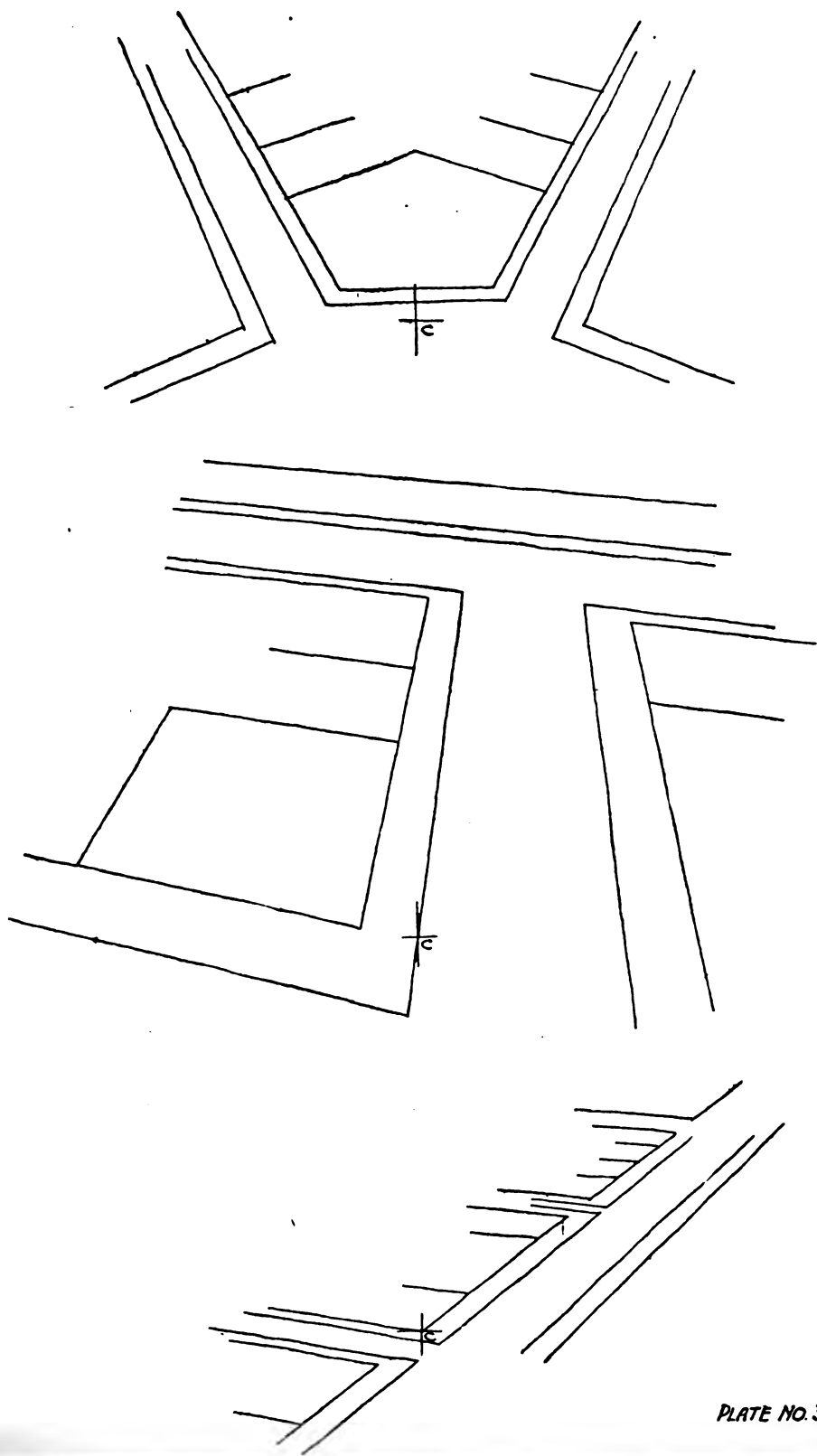


PLATE NO. 34



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24.

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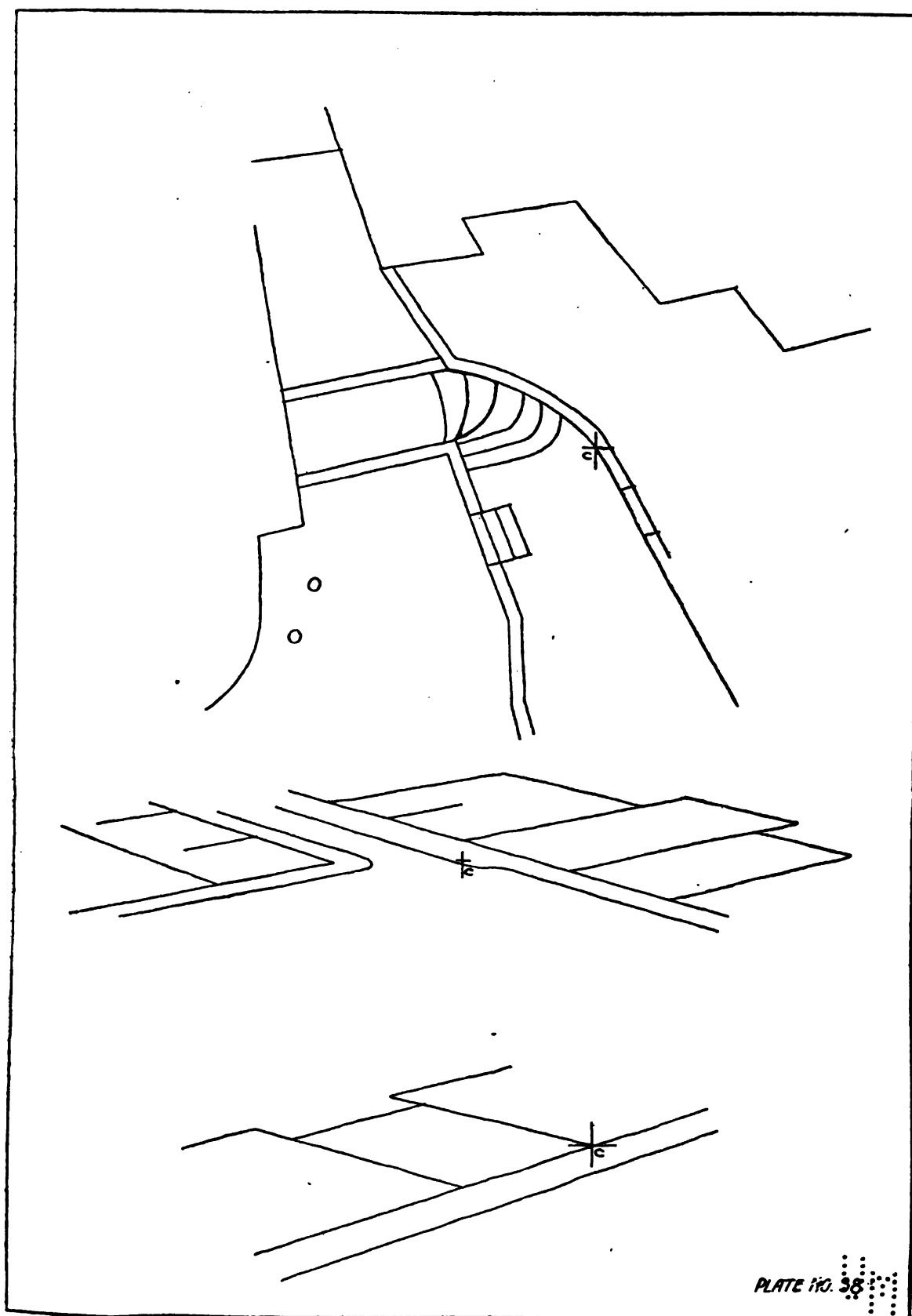


PLATE NO. 38

nd

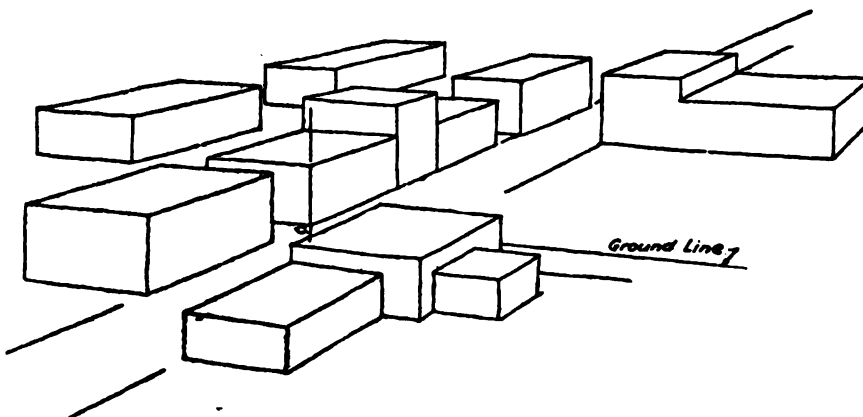
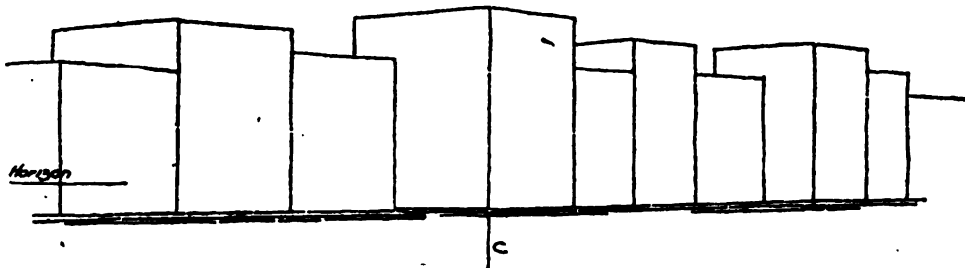
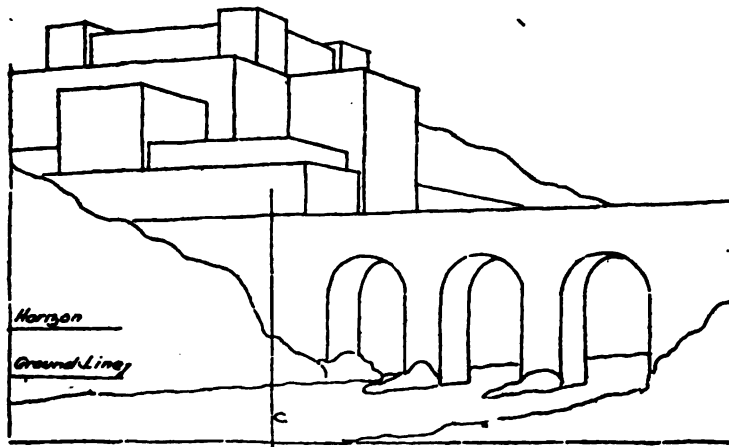


PLATE NO. 39



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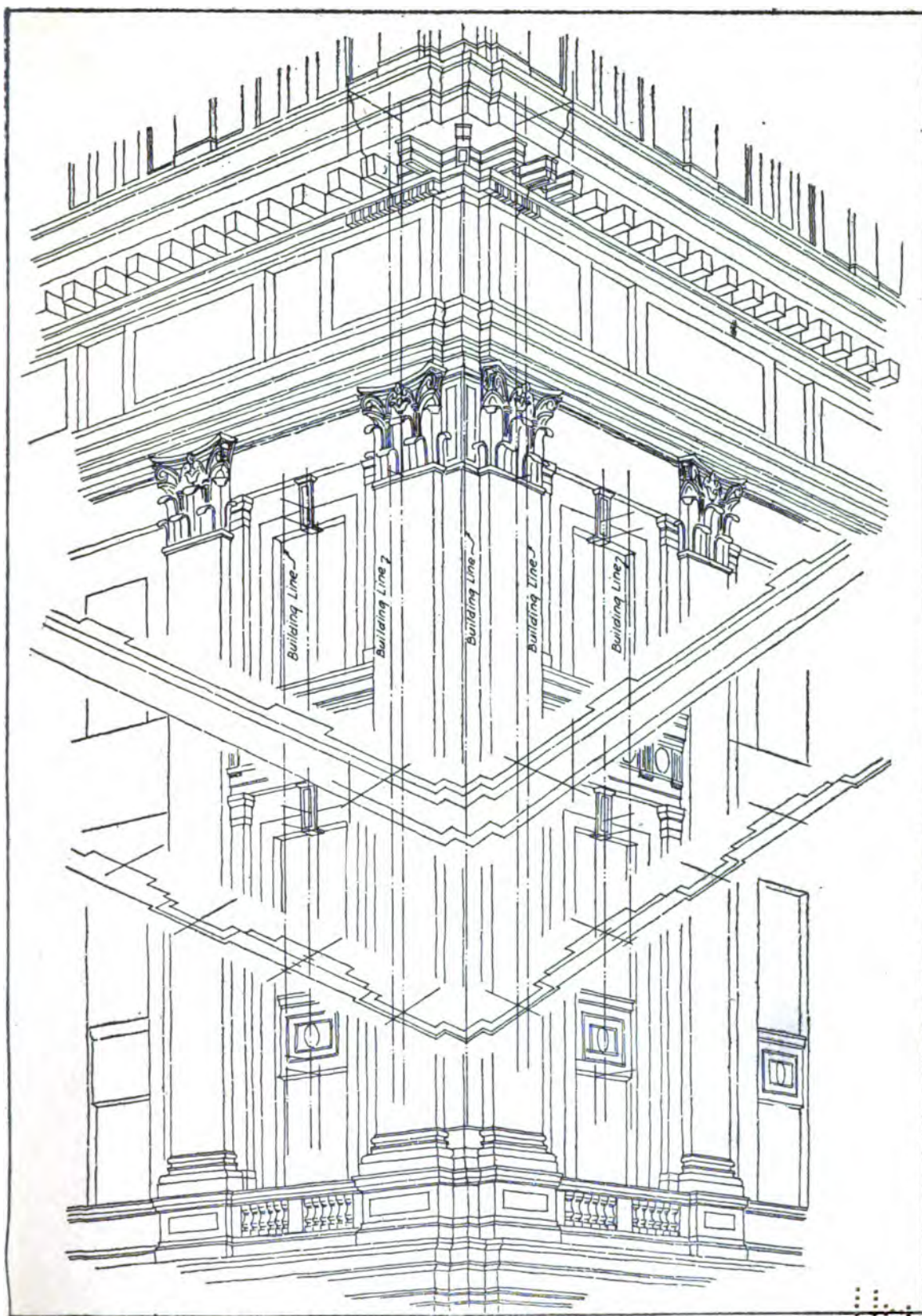


PLATE NO. 40

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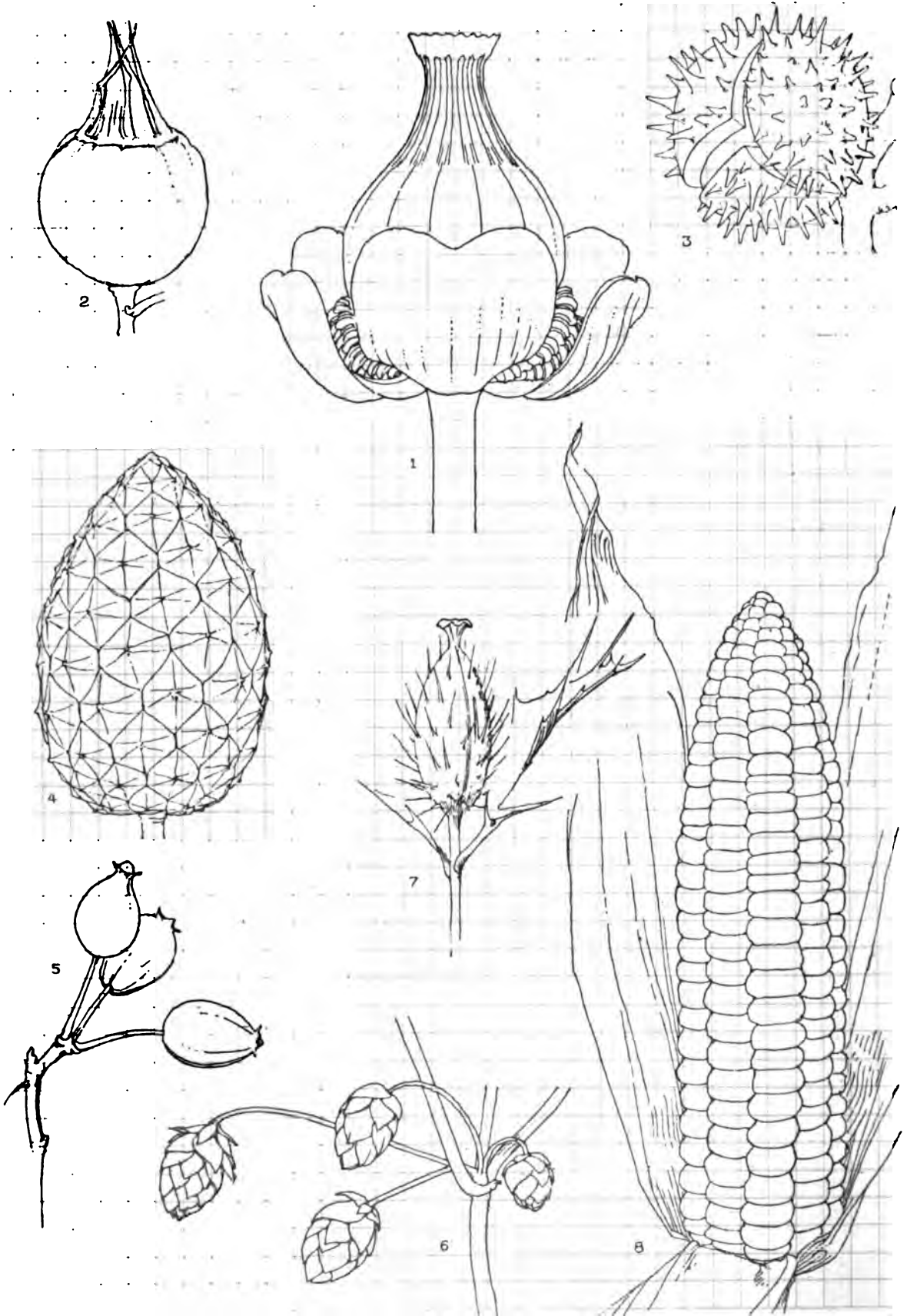
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